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MP-40/MP-40E
POWER SUPPLY
Instruction Manual

Honeywell

COMPUTER CONTROL DIVISION

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MP-40/MP-40E
POWER SUPPLY
Instruction Manual

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August 1968

Honeywell
COMPUTER CONTROL
DIVISION

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FOREWORD

This manual is designed as a guide for installing, testing, operating and maintaining the MP-40/MP-40E Power Supply.

The MP-40/MP-40E Power Supply unit is built for Honeywell by Ault Incorporated (Model No. PR36) and by the North Electric Company (Model No. PEC-3184). Documentation provided by these two companies is presented here in two parts. The Ault power supply is documented in Part I; the North Electric power supply is documented in Part II. Part I contains two sections. Section 1 contains documentation for Model PR36-A1 (MP-40) for serial number 0 to 194 and Model PR36-B1 (MP-40E) for serial number 0 to 30. Section II contains documentation for Model PR36-C1 (MP-40) for serial numbers 195 and above and Model PR36-D1 (MP-40E) for serial numbers 31 and above.

MP-40/MP-40E POWER SUPPLY SPECIFICATIONS

Input AC Power

Frequency:	MP-40: 60 ±1 Hz MP-40E: 50 ±1 Hz
Voltage:	Either of the following with proper external connections of transformer taps. 95-130 Vrms 190-260 Vrms
Line Current:	12 amperes at 115 volts nominal 6 amperes at 230 volts nominal

Output Power

All three outputs are dc voltages.

Output Voltage (Vdc @25°C)	Adj Range	Average Current	Voltage Regulation
+24 Vdc	±5 Vdc	0 - 13A	±2%
+6 Vdc	±5%	3 - 10A	±2%
-6 Vdc	±5%	0.15 - 1.5A	±2%

Ripple

2% p-p.

Temperature Compensation

The +24V output is compensated for temperature variations.

Overvoltage Protection

The +24V output will not exceed nominal voltage by more than 15%. Before the -6V output exceeds nominal voltage by more than 30%, or before the +6V output exceeds nominal voltage by more than 30%, a crowbar mechanism is energized which removes the overvoltage condition.

Overload Protection

All outputs are protected against overload conditions.

Overtemperature Protection

The power supply will shut down if it becomes overheated.

Operating Temperature

The power supply is capable of operating at ambient temperatures between 0 and 60°C.

Sequencing and Power Control

The turn-on of the 24V supply is delayed such that the +6V and -6V supplies exceed 90% of nominal before the 24V output exceeds 20% of nominal. A +6V fault signal is provided to indicate that the ac line is within the proper limits. During turn off, the +6V fault signal disappears first. After a minimum delay of 1 millisecond, the 24V output turns off. The +6V and -6V outputs remain in the regulation band until the 24V output has decreased to less than 20% of nominal.

Isolation

All output voltages are isolated from input ac voltage and from the chassis.

Dimensions

19 in. x 19 in. x 5 in.

Weight

70 lb

PART I

Power Supplies

Ault, Inc.

PART I

SECTION I
MP-40/40E POWER SUPPLY (AULT)*

INTRODUCTION

This section contains the information needed for installation, adjustment, operation, and maintenance of the MP-40 (PR36-A1, Serial 0 to 194) and MP-40E (PR36-B1, Serial 0 to 30) power supplies. The MP-40 and MP-40E are identical multiple-output power supplies except for input power requirements. The MP-40 is designed to operate at 60 ±1 Hz, and the MP-40E is designed to operate at 50 ±1 Hz. The transformer (T101) and choke (L101) are the only components that differ between the two supplies.

NOTE

This section should be read thoroughly before operating the equipment.

REFERENCED DRAWINGS

The following diagrams are included at the end of this section.

Drawing No.	Figure No.	Title
PR36-A2-1	1-20	MP-40/MP-40E Installation
PR36-A2-2	1-21	MP-40 Power, 60 Hz
480-2409	1-22	+24V Control
408-2410	1-23	±6V Control

Component reference numbers in the 100 series (i.e., R101, CR102, etc.) refer to components shown in Circuit Diagram PR36-A2-2. Reference numbers in the 200 series refer to components shown in Circuit Diagram 480-2410. Reference numbers in the 300 series refer to components shown in Circuit Diagram 480-2409.

MECHANICAL DESCRIPTION

The top cover of the MP-40 power supply is easily removed to provide access to power supply components. All high-power dissipating components are mounted on heat sinks. Low-power control components are mounted on two etched circuit boards.

The MP-40 power supply can be mounted either horizontally or vertically. The normal horizontal configuration is designed for standard 19-inch rack mounting. Removal of the front panel and rotating the meter panel 90 degrees allows vertical mounting of the power supply.

*The information in this section is presented with the permission of the manufacturer, Ault, Incorporated, 3501 48th Avenue North, Minneapolis, Minnesota, 55429.

ELECTRICAL DESCRIPTION

A complete description of the operation of the MP-40 power supply has been provided previously in this manual. Briefly, the MP-40 power supply provides three regulated dc outputs which are isolated from the chassis and from the input ac line voltage. Nominal values of these voltages are +24 Vdc, +6 Vdc, and -6 Vdc.

The power supply provides turn-on and turn-off sequencing, overload protection, overvoltage protection, and overtemperature protection. Overtemperature or low-line conditions will shut down the power supply. Overload or overvoltage conditions will drop the affected output to a low voltage.

Magnetic Components

Components T101 and L101 will be different for 60 Hz and 50 Hz operation. Part numbers for the appropriate components are:

Reference No.	MP-40 (60 Hz)	MP-40E (50 Hz)
T101	301-1209	301-1214
L101	302-1219	302-1221

Special Testing Equipment

A circuit card puller (No. 685-1081) and a circuit card extender (No. 180-1960) are available directly from Ault Incorporated.

INSTALLATION AND ADJUSTMENT

UNPACKING

Care should be used when unpacking the MP-40 power supply. Inspection for physical damage should be made on arrival.

INSTALLATION PROCEDURE

Mounting

Provisions have been made, as specified by Honeywell Computer Control Division, for mounting the MP-40 power supply.

External Connections

(See installation drawing Figure 1-20.) All external connections are made through terminal strips TB101 through TB113, connector J103 and a chassis ground stud (located on the rear panel).

Terminal	
1	Connect to terminal 2 of TB101 for 95-130 volts input.
	Terminal 1 is not connected for 190-260 volts input.
2	Connect to terminal 1 of TB101 for 95-130 volts input.
	Connect to terminal 3 of TB101 for 190-260 volts input.
3	Connect to terminal 4 of TB101 for 95-130 volts input.
	Connect to terminal 2 of TB101 for 190-260 volts input.
4	Connect to terminal 3 of TB101 for 95-130 volts input.
	Terminal 4 is not connected for 190-260 volts input.
TB102	24V output, + terminal
TB103	24V output, + terminal
TB104	24V output, - terminal
TB105	24V output, - terminal
TB106	+6V output terminal
TB107	+6V output terminal
TB108	-6V output terminal
TB109	-6V output terminal
TB110	±6V common
TB111	±6V common

Terminal	
TB112-1	Temperature programming resistor
TB112-2	Temperature programming resistor
TB112-3	Fault signal
TB113-1	Temperature programming resistor
TB113-2	Temperature programming resistor
TB113-3	Fault signal

J103

Input ac connections are made through this connector.

Transformer Tap Connections

NOTE

Transformer tap connections at TB101 must be correct before input power is applied. Refer to the preceding paragraph for the necessary connections.

External Temperature Sense Connections

To operate the power supply, a thermistor (Ferroxcube No. B832007P/4K7S, 3C Part No. 932 300 004) must be connected across the R_T terminals of TB112 or TB113. The thermistor should be connected at the same location as the load connection.

Chassis Ground

NOTE

To insure safety of operating personnel, the chassis must be connected to system ground using the 10-32 threaded stud on the rear panel.

Fuse Protection

NOTE

Fuse F105 must be changed when converting from 115V to 230V operation. F105 is a standard glass fuse rated at 15 amperes at 115V or 8 amperes at 230V. Fuses F101, F102, and F103 are standard glass fuses and provide overcurrent protection. Fuse F104 protects the fan motor against excessive current. F101 is rated at 20 amperes, F102 at 15 amperes, F103 at 5 amperes and F104 at 1/4 ampere.

SPECIAL REQUIREMENTS

Restarting After Overvoltage or Low-Line Conditions

If loss of line, excessively low-line, or overvoltage conditions on the +24V or +6V outputs occur, a crowbar mechanism is energized which shorts these two outputs. To restart, input power must be temporarily removed to allow the crowbar mechanism to reset.

Requirement for Fast Turn-On

If the input ac voltage is brought up slowly, the crowbar mechanism will be activated before the +6V and -6V outputs are turned on. The crowbar mechanism then prevents them from turning on. Refer to the preceding paragraph.

Overcurrent Protection

The series regulators for the ±6V and +24V outputs contain electronic current limiting circuitry which limits current to approximately 125% of rated load current. Fuses F101, F102, and F103 provide additional overcurrent protection in case the current limiting circuitry fails.

Temperature Compensation

The +24V output is compensated for temperature changes by a thermistor which must be connected across terminals R_T of TB112 or TB113. The 24V load can be connected on either the side or the rear of the power supply. To insure proper compensation, the thermistor should be connected at the same location as this load connection. The compensation coefficient of the thermistor is approximately -0.5% per degree C.

POWER SUPPLY ADJUSTMENT

All power supply adjustments are preset at the factory and normally need no adjustment. However, if adjustments are necessary, proceed as shown in the following sections. The potentiometers corresponding to each adjustment are:

Potentiometer	Adjustment
R216	+6V Output Voltage Adjustment
R242	-6V Output Voltage Adjustment
R249	Line Voltage Sense Adjustment
R326	+24V Output Voltage Adjustment

+24V Output Voltage Adjustment

The +24V output is adjusted using potentiometer R326. Turning R326 clockwise increases the output voltage.

+6V Output Voltage Adjustment

The +6V output is adjusted using potentiometer R216. Turning R216 clockwise increases the output voltage.

-6V Output Voltage Adjustment

The -6V output is adjusted using potentiometer R242. Turning R242 clockwise increases the magnitude of the output voltage.

Line Voltage Sense Adjustment

Transformer T102 senses the line voltage level for use by the control circuit. Adjustment of this sensing circuit is made as follows.

a. Turn R249 fully counterclockwise.

b. Make transformer tap connections to terminal block TB101 for 115 Vrms operation.

c. Apply 115 Vrms input line voltage.

d. Reduce line voltage to 94 Vrms.

e. Turn R249 clockwise until the +24V output turns off.

f. Before the power supply will operate again, input power must be momentarily removed.

DESCRIPTION

As in any control system, 3C power supplies are merely a combination of simpler circuits, any one of which is easily understood. This section describes and relates these simpler circuits to provide a complete understanding of the MP-40 power supply. Component reference numbers shown in diagrams in this section are the same reference numbers shown in circuit diagrams listed previously in this manual.

DEVICE DESCRIPTION

The following is a description of the less familiar devices used in this power supply.

Zener Diodes

A normal diode voltage-current characteristic looks like that shown in Figure 1-1.

For silicon diodes, particularly of the diffused junction types, there is an abrupt breakdown in the reverse direction as shown by the dotted line in the figure. As can be seen from the sketch, any current in excess of I_{R1} drawn through the device in the reverse direction will result in a constant voltage appearing across the device. Silicon diodes designed to utilize this feature are called "zener" types. This constant voltage is used as a voltage reference source in all 3C power supplies. The symbol for a zener diode is shown in Figure 1-2. In a circuit application, the zener diode is connected in series with a current-determining resistor across some dc voltage as in Figure 1-3.

Silicon-Controlled Rectifiers

A silicon-controlled rectifier (SCR) is a device that blocks current flow in both directions until a pulse is put into what is called the "gate." At this time, the device will conduct in one direction; it will block current in both directions only after the current has been reduced to zero. The symbol for a SCR is shown in Figure 1-4; "G" designates the gate lead.

MP-40 POWER SUPPLY

Figure 1-5 is a block diagram of the MP-40 power supply. Input ac is delivered to the constant voltage transformer (CVT), providing preregulation for the three power supply outputs. Also, three control voltages for use within the power supply are derived from the CVT. The two series regulators further regulate the voltage from the CVT to provide the +24V and the +6V outputs. Additional regulation for the -6V output is provided by a shunt regulator. A temperature-compensated reference voltage is provided for the +24V series regulator.

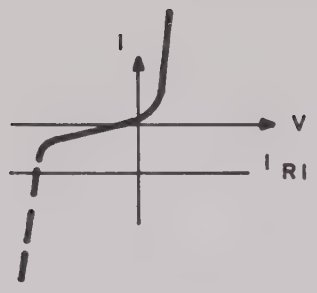


Figure 1-1. Diode Voltage-Current Characteristic

Figure 1-2. Zener Diode Symbol

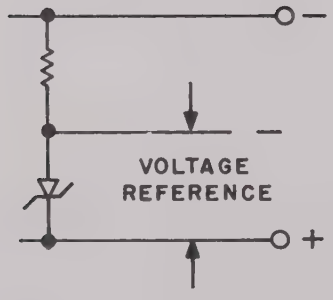


Figure 1-3. Zener Diode Circuit Connection

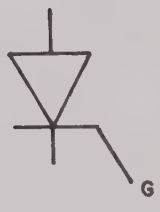


Figure 1-4. Silicon-Controlled Rectifier Symbol (G = Gate)

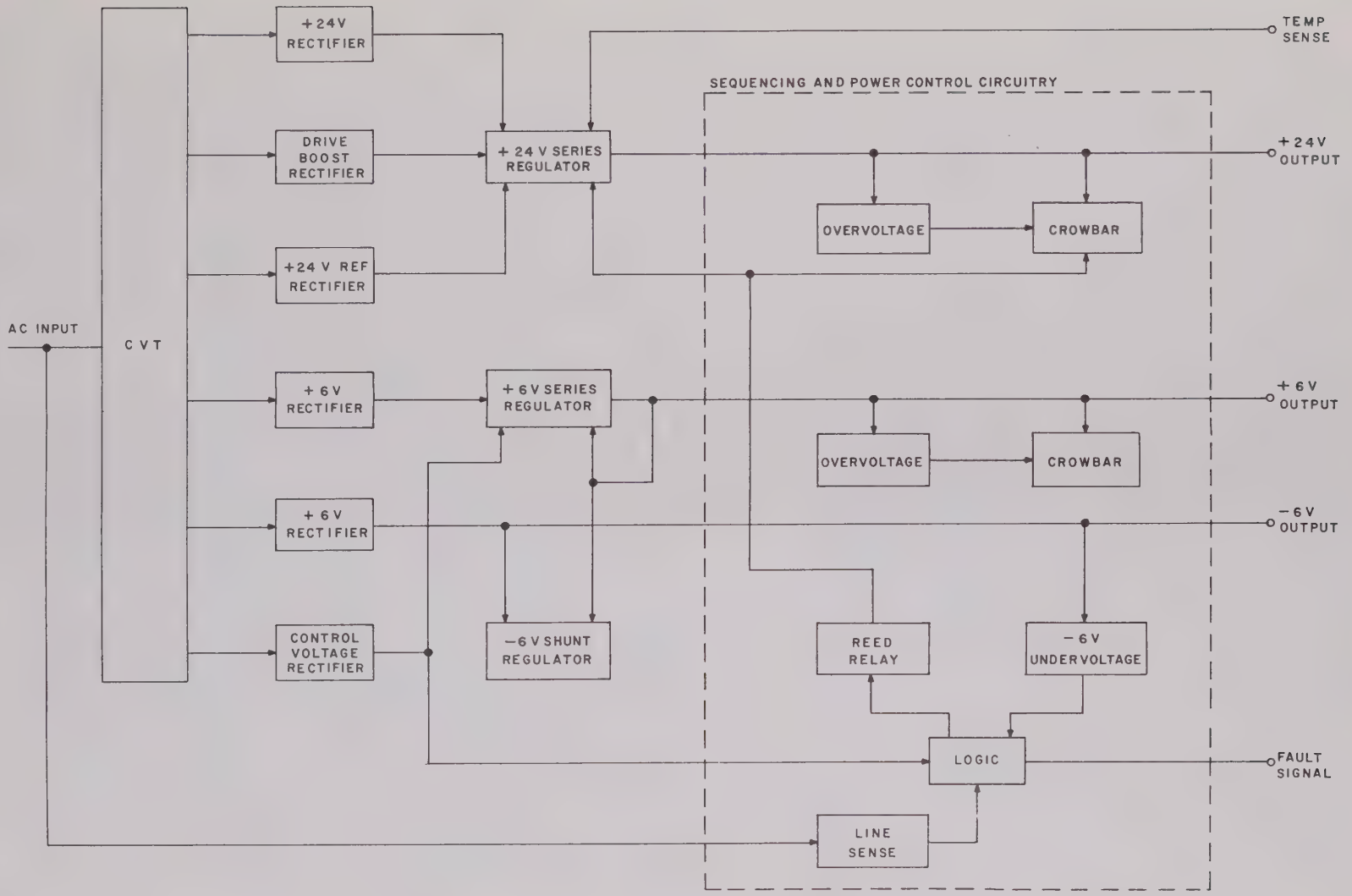


Figure 1-5. Power Supply, Model MP-40/MP-40E, Block Diagram

The sequencing and power control circuitry is enclosed by dotted lines in the block diagram. The crowbar circuits clamp the +6V and +24V outputs when a signal is received from the overvoltage circuit. The logic circuit provides control for the +24V turn-on relay when signals are received from the -6V undervoltage circuit or the line sense circuit. A +4 to +6 volt fault signal is provided during normal operation.

When the power supply is turned on, the ±6 volt outputs and the fault signal appear before the 24V output. The charge rate of the output filter capacitors delay the rise of the ±6V outputs until the line voltage is high enough to prevent the line sense circuit from firing the silicon controlled rectifier which grounds the ±6V outputs when a low line condition occurs. When the ±6V outputs have exceeded 90% of nominal, the 24V turn-on relay is energized, which controls the 24V output.

Overvoltage conditions on the +6V and +24V outputs are sensed by the respective overvoltage circuit, which provides a trigger signal to its crowbar circuit. This quickly drops the affected output to a very low voltage. During turn-off or loss of ac power, the 24V output is held on for a minimum of 1 millisecond by a capacitor. The 24V turn-on relay then opens, and the 24V output is quickly dropped to a low voltage by the crowbar circuit. The ±6V outputs remain in the regulation band until the +24V output has decreased to less than 20% of nominal.

The Constant Voltage Transformer

The constant voltage transformer (CVT) is a device for producing ac voltages of constant magnitude that can be rectified and filtered to produce regulated dc output voltages. If necessary, these outputs can then be further regulated by series regulators.

The CVT system used in the MP-40 power supply is shown in Figure 1-6. Only one of the secondaries of T101 has been included, since each secondary circuit functions in the same manner. (Each secondary voltage is rectified and filtered to provide a dc output.) Single-phase ac power is supplied across L101 and the primary of T101. (The primary has been split to allow the supply to be operated from 115V or 230 Vac power.) The voltage waveform that will appear on each secondary of T101 is shown in Figure 1-7. Transformer T101 is capable of supporting a predetermined voltage without saturating. Choke L101 will absorb the difference between this voltage and the input line voltage. When T101 is not saturated, rectifier CR101 or CR102 will be forward biased, causing the predetermined voltage to appear across filter capacitors C103 and C104 and the load. When T101 starts to saturate, the rectifiers are reverse-biased and no longer conduct. Resonant action of C101 and C102 and the saturation inductance of T101 cause T101 secondary voltages to ring to equal and opposite levels. T101 again becomes unsaturated and the rectifiers conduct. As a result, a regulated dc output is obtained from each secondary of T101.

The large flux swings of T101 cause increased core losses, resulting in increased power dissipation. T101 runs at a higher temperature than conventional power transformers, but this higher temperature does not indicate a system malfunction.

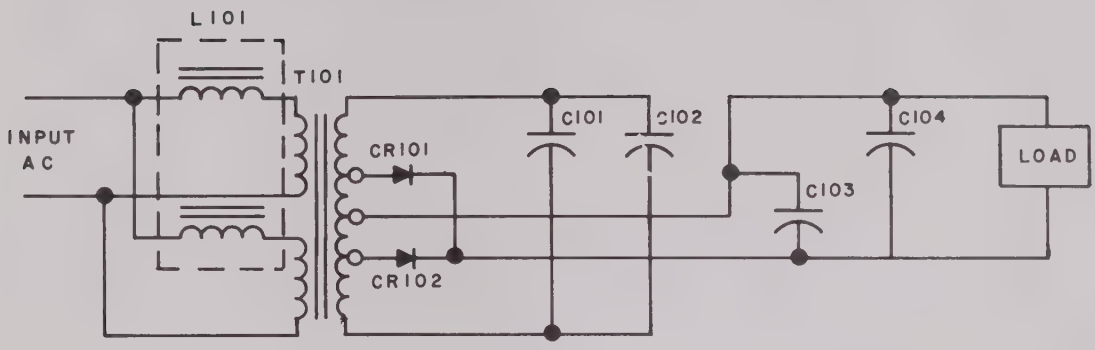


Figure 1-6. Constant Voltage Transformer, Schematic Diagram

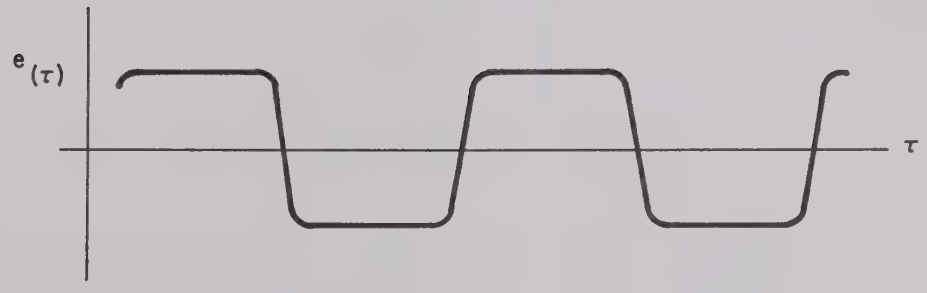


Figure 1-7. Secondary Winding Voltage Waveform

+24V Series Regulator Circuit

The +24V series regulator provides further regulation of a dc voltage from constant voltage transformer T101. Figure 1-8 is a block diagram of a typical series regulator. The +24V series regulator is shown in Figure 1-9 with the blocks of Figure 1-8 indicated by dashed lines.

When the 24V turn-on relay closes a positive dc voltage is supplied to zener diode CR309 of the +24V constant current drive circuit. In this circuit, Q310 provides a constant current source which is determined by zener diode CR309, resistor R311, and the emitter-base forward voltage drop of Q310. This current is supplied to the base of Q303. The emitter current of Q303 provides base drive current for Q107, which in turn provides base drive current for power transistors Q101 through Q106. These transistors are connected in parallel to provide the required load current. Resistors R101 through R106 compensate for differences in the gain of transistors Q101 through Q106 such that they share the load current equally. The load current is filtered by C113. Transient protection is provided for the 24V output by C114, C115, C116, and C117.

Regulation is provided by controlling Q308 current. Whenever Q308 conducts, it shunts drive current (supplied by Q310) away from the base of Q303, which in turn reduces drive current to Q107 and therefore reduces +24V load current. The +24V output can thus be regulated by controlling Q308. The base current of Q308 is determined by Q307 base current. Q307 base current will be the difference between R315 current and the current shunted away through CR303 and CR304. CR304 current will be the difference between R318 current and R320 current. Since R320 current is fixed by the reference voltage level, this difference current is controlled through R318 by output voltage. The net result is that R318 current varies Q308 emitter current as required to hold the +24V output voltage constant.

Transistors Q307 and Q308 are stabilized by R314, C303, R332 and C305. These components prevent oscillation of the +24V output. Diodes CR303 and CR304 are used to compensate for changes in emitter-base voltage drops across Q307 and Q308 as temperature varies. Resistor R326 provides voltage adjustment for the +24V output. CR110 prevents damage to the regulator in the event that a reverse voltage is applied to the +24V output terminals.

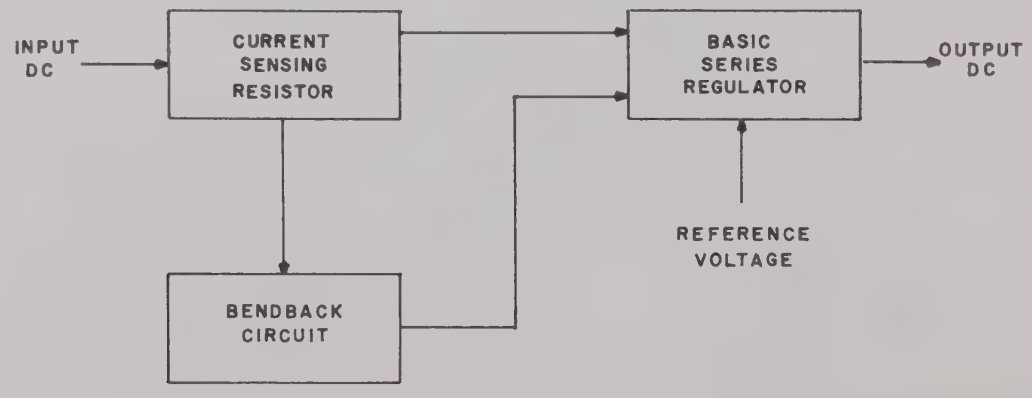


Figure 1-8. Series Regulator, Block Diagram

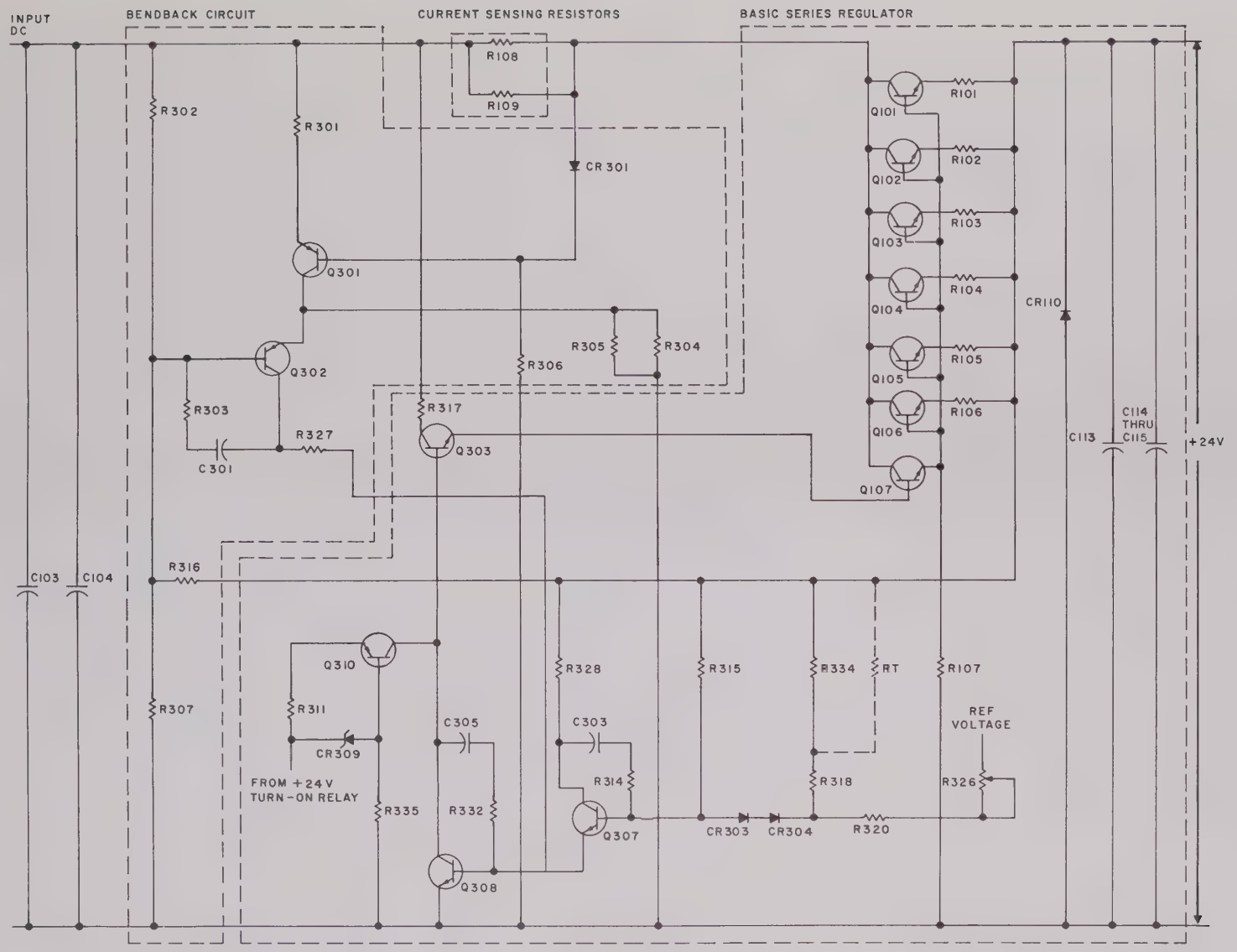


Figure 1-9. +24V Series Regulator, Schematic Diagram

If the +24V output is overloaded, the bendback circuit operates. The +24V output has a bendback characteristic as shown in Figure 1-10. The small voltage across current-sensing resistors R108 and R109 also appears across R301, so that Q301 emitter current (and therefore Q301 collector current) is proportional to load current. Q301 collector current flows through R304 and R305. Transistor Q302 compares the voltage across R304 and R305 to the voltage across R307, which is derived from input dc and output dc through R302 and R316, respectively. When the maximum load is exceeded, Q302 emitter voltage exceeds Q302 base voltage and the transistor conducts. This provides current through R327, which increases the base drive current of Q308. The amount of current shunted away from the base of Q303 is increased and therefore output current is reduced, providing the desired bendback characteristic. C301 and R303 stabilize Q302, preventing oscillation of the bendback circuit. R305 is selected to determine the current level at which bendback occurs.

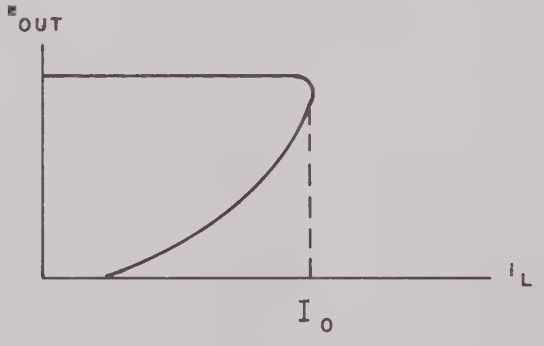


Figure 1-10. Series Regulator Output Voltage-Current Characteristic

The +24V output is temperature compensated by the external thermistor connected across terminals R_T of TB112 or TB113. (A thermistor is a resistor whose resistance varies inversely with temperature.) The thermistor is connected in parallel with R334. The temperature changes at the thermistor location will vary the current through R318 and will therefore vary the output voltage accordingly.

+6V Series Regulator Circuit

The +6V series regulator is similar to the +24V series regulator. This regulator is shown in Figure 1-11.

Transistor Q204 receives base drive from the constant current drive circuit consisting of CR204, Q203, and R210. The emitter current of Q204 provides base drive for Q111, which in turn supplies base drive current for power transistors Q108, Q109, and Q110. Resistors R117, R118, and R119 compensate for differences in the gain of these transistors such that they share the load current equally. C108 filters the +6V output voltage. Transient protection for the +6V output is provided by C111 and C112.

Regulation is provided by controlling Q205 current. Whenever Q205 conducts, it shunts drive current away from the base of Q204, which in turn reduces drive current to Q111 and therefore reduces +6V load current. The +6V output can thus be regulated by controlling Q205. The base current of Q205 is determined by Q206 base current, which is determined by the difference between R215 current and the current shunted away through CR205 and CR206. This current will be the difference between R217 current and R218 current. Since R218 current is fixed by the reference voltage level, this difference current is controlled through R217 by output voltage. The net result is that this difference current varies Q205 emitter current as required to hold the +6V output voltage constant.

Transistor Q205 is stabilized by C202 and R213. These components prevent oscillation of the +6V output. Diodes CR205 and CR206 are used to compensate for changes in the emitter-base voltage drops of Q205 and Q206 as temperature varies. R216 provides voltage adjustment for the +6V output. CR109 protects the series regulator from damage in the event that a reverse voltage is applied to the +6V output terminals.

The +6V bendback circuit will operate when the +6V output is overloaded. The bendback characteristic of the +6V output is similar to that of the +24V output as shown in Figure 1-10. The small voltage across current sensing resistor R110 appears across R201 so that Q201 emitter current (and therefore Q201 collector current) is proportional to load current. Q201 collector current flows through R204 and R205. Transistor Q202 compares the voltage across R204 and R205 to the voltage across R206. (The voltage across R206 is derived from input dc and output dc by R202 and R207, respectively.) When the maximum load is exceeded, Q202 starts to conduct, providing current through R209 which increases the base drive current of Q205. The amount of current shunted away from the base of Q204 is increased and therefore the load current is reduced, providing the desired bendback characteristic. C201 and R208 stabilize Q202, preventing oscillation of the bendback circuit. R204 is selected to determine the current level at which bendback occurs.

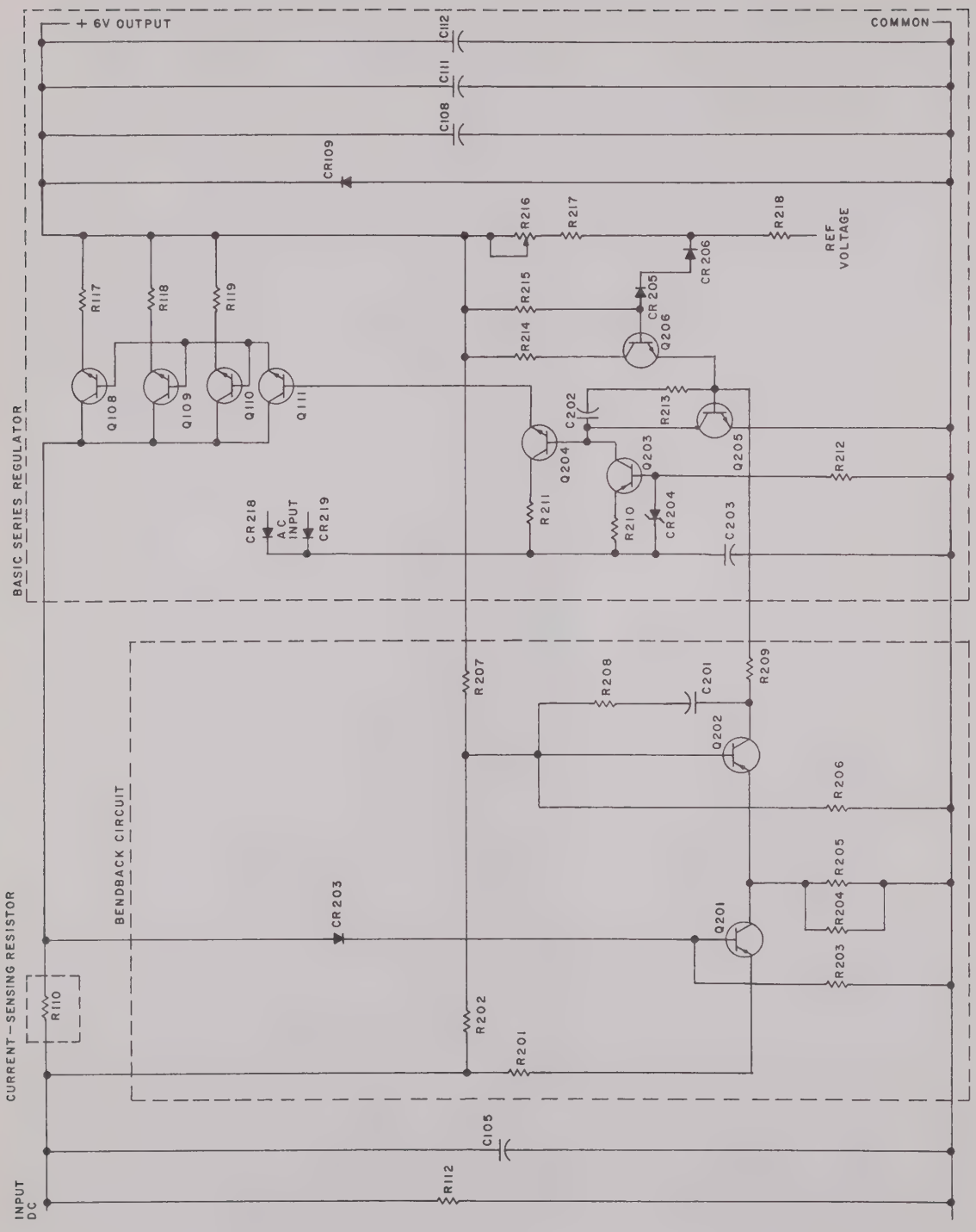


Figure 1-11. +6V Series Regulator, Schematic Diagram

-6V Shunt Regulator Circuit

Regulation of the -6V output is provided by the shunt regulator shown in Figure 1-12. One secondary of the constant voltage transformer system provides a dc voltage across C106, providing input power to the shunt regulator. Load current and the current shunted through transistor Q113 flows through resistor R122. The voltage drop across this resistor accounts for the difference between the input dc voltage across C106 and the -6V output voltage across C107. As the load current varies, the shunt regulator controls the current through Q113 such that the voltage drop across R122 will be that necessary to maintain the output at -6 volts.

Drive current for Q113 is provided by Q112. Drive current for Q112 is provided by Q215. The shunt regulator control circuit (shown in dotted lines in Figure 1-12) controls Q215 current such that Q113 conducts as required to hold the output at -6 volts.

The output voltage of the +6V series regulator is used for -6V reference voltage. (A decoupling circuit consisting of CR207 and C204 is used to prevent +6V output transients from affecting regulation of the -6V output.) This voltage generates a constant current through R218, which provides a maximum base drive for Q213. The current through R241 shunts part of this drive current away from Q213. Q213 collector current controls Q214 base current. Q214 collector current controls Q215, which in turn controls Q112 and Q113. The net result is that R241 current varies as required to hold the -6V output at a constant voltage.

+6V Overvoltage and Crowbar Circuit

The +6V overvoltage and crowbar circuit is shown in Figure 1-13. When an overvoltage condition is detected on the +6V output, the crowbar circuit is triggered, reducing the +6V output to a low voltage. Q211 is normally held off by R236 current, which is derived from a negative reference voltage. When the +6V output rises above the maximum allowable voltage, the current through R238 exceeds R236 current, and Q211 turns on. Q211 collector current then supplies base drive for Q212, and Q212 turns on. Q212 then provides a gate signal for silicon controlled rectifier CR108. CR108 then turns on and shorts out the +6V output through R114. This quickly drops the +6V output to a very low voltage.

+24V Overvoltage and Crowbar Circuit

The +24V overvoltage and crowbar circuit is shown in Figure 1-14. When an overvoltage condition occurs on the +24V output, the overvoltage circuit provides a gate trigger signal to the +24V crowbar circuit, which drops the +24V output to a low voltage. During normal operation, R321 current, which is derived from a negative reference voltage, flows through CR312 and holds Q306 off. When the +24V output rises above the maximum allowable voltage, the current through R322 exceeds R321 current, which turns Q306

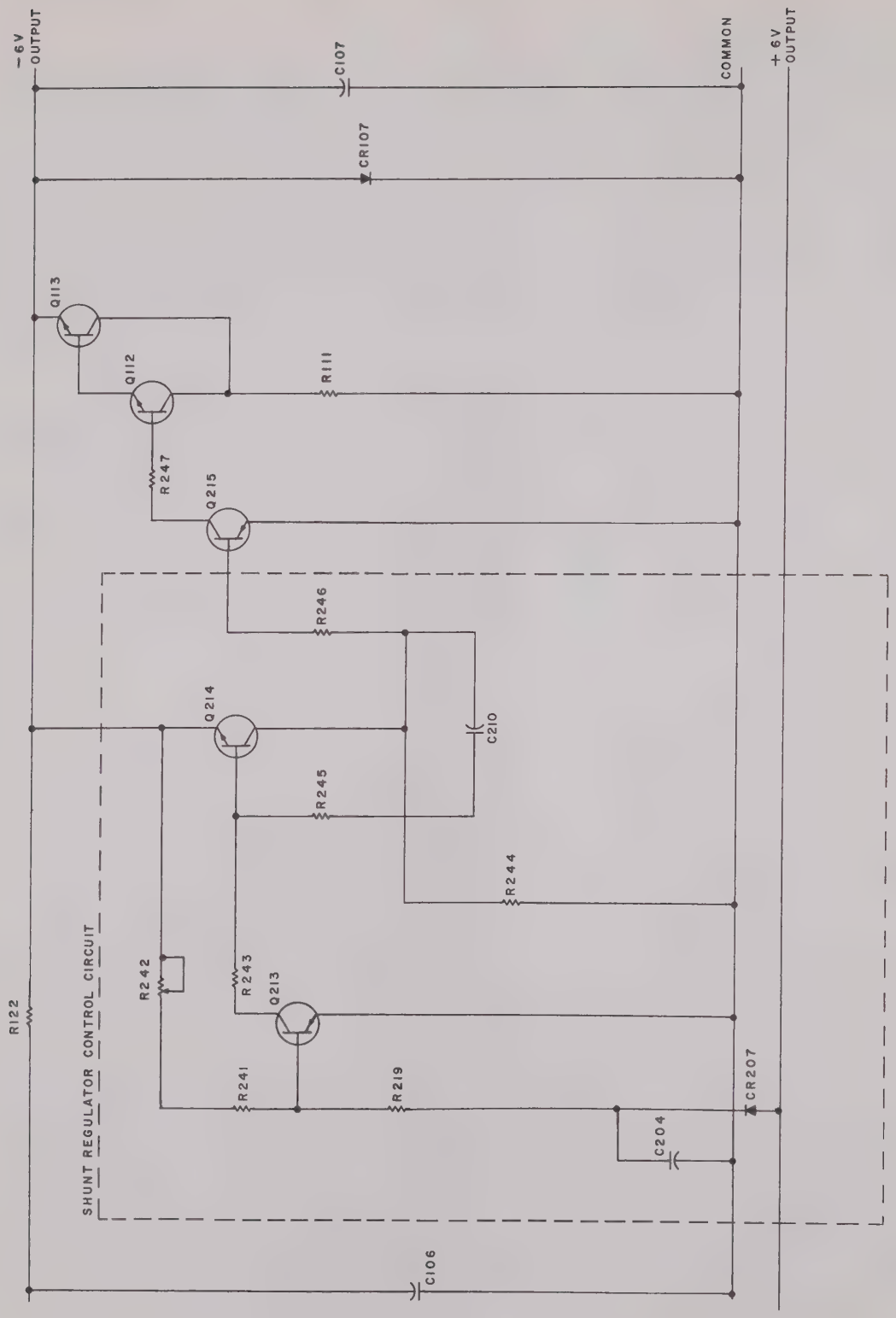


Figure 1-12. -6V Shunt Regulator, Schematic Diagram

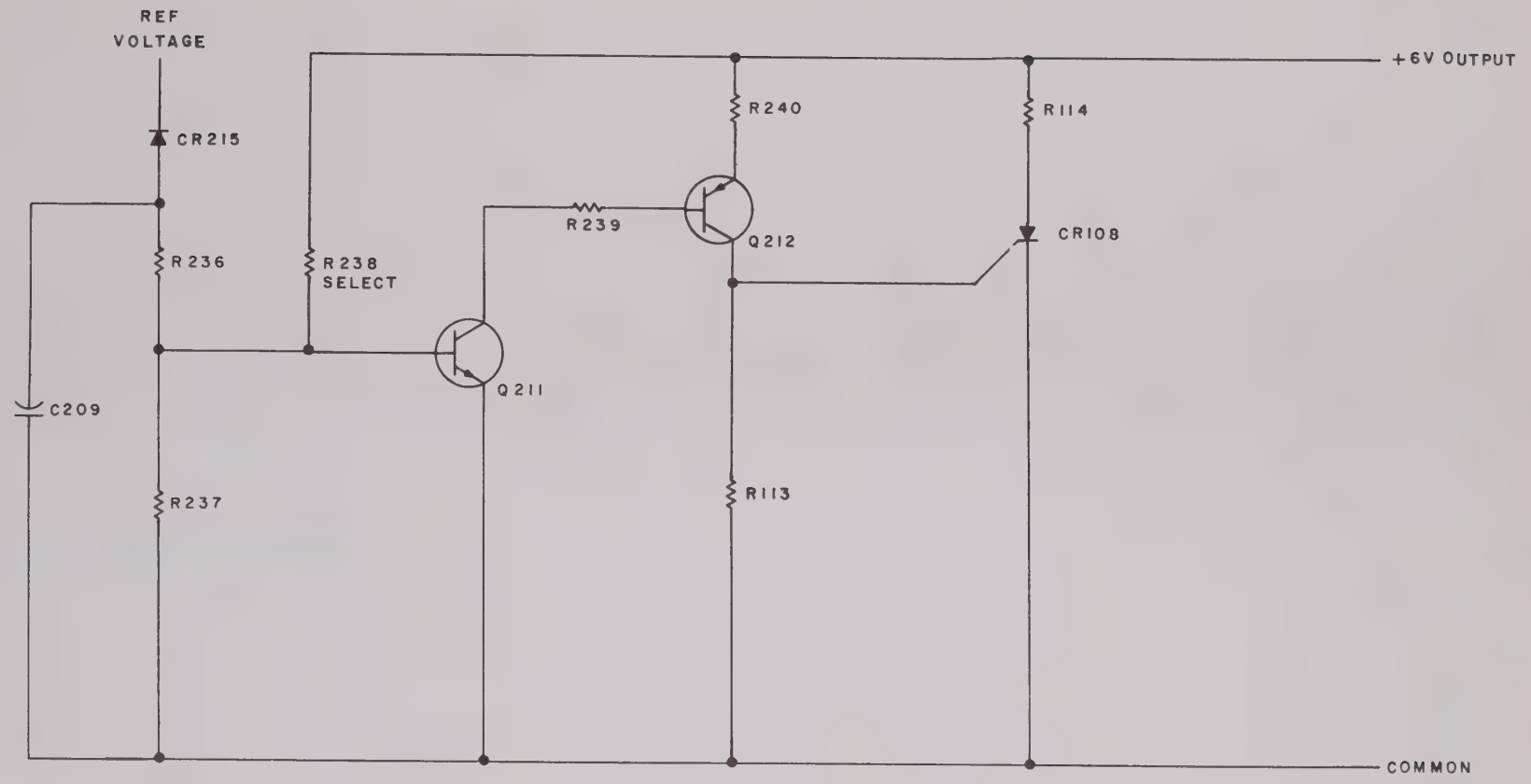


Figure 1-13. +6V Overvoltage and Crowbar Circuits, Schematic Diagram

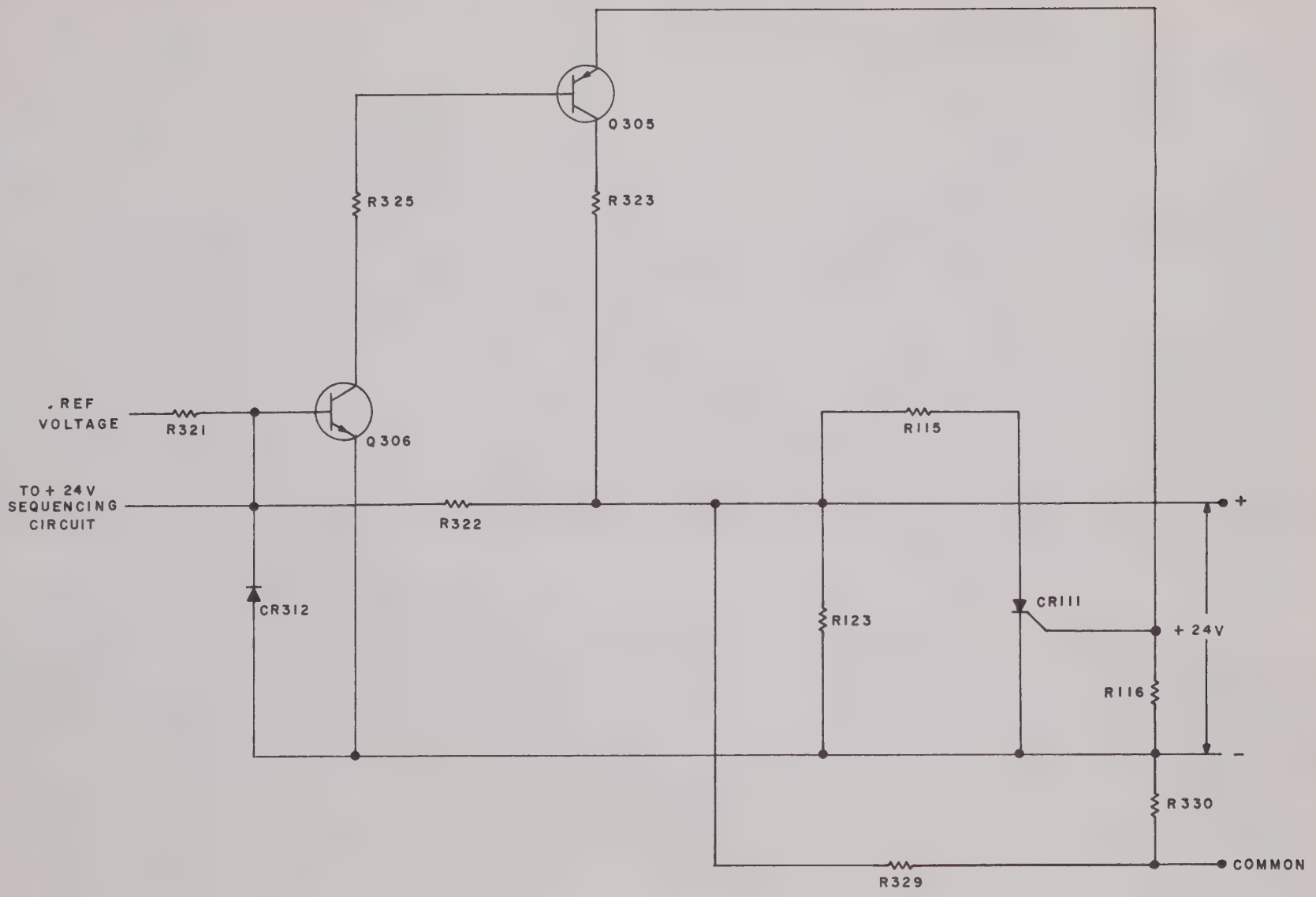


Figure 1-14. +24V Overvoltage and Crowbar Circuits, Schematic Diagram

on. Q306 collector current then turns Q305 on, which in turn provides a gate signal for silicon-controlled rectifier CR111. CR111 then turns on, and the +24V output is quickly dropped to a very low voltage. System power must be temporarily interrupted to restore the +24V output. Resistors R329 and R330 are used to derive the ±12V output (with respect to the ±6V common) from the +24V output terminals. Resistor R123 is included to keep the +24V output at light load if the load is removed.

+24V Sequencing Circuit

The +24V sequencing circuit is shown in Figure 1-15. The +24V turn-on relay coil (K301) is energized by the +24V turn-on circuit when the ±6V outputs have exceeded 90% of nominal. When the contacts of K301 are closed, a dc voltage is supplied to the constant current drive source of the +24V series regulator, allowing the +24V series regulator to turn on. This voltage is comprised of the input voltage to the +24V series regulator and an additional dc boost voltage (across C306) derived from a separate winding of constant voltage transformer T101 through rectifiers CR310 and CR311. The additional boost voltage is provided to insure that adequate drive is available for the +24V series regulator.

During turn-off or a loss of line condition, the +24V output must remain in regulation for at least 1 millisecond, and the +24V output must be dropped to 20% of nominal before either the -6V or +6V output drops out of regulation. The 1 millisecond delay in turning off the +24V output is provided by an RC network consisting of R309 and C302. This network delays the dropout of K301. When K301 does drop out, drive current for Q309 is removed, Q309 turns off, and current flows through R313 to the +24V overvoltage circuit. This current is sufficient to trigger the +24V overvoltage circuit (Figure 1-14), which in turn crowbars the +24V output. Crowbarring this output insures that it will be below 20% of nominal before the ±6V outputs drop out of regulation.

Reference Source Circuit for +6V Output

The reference source circuit for the +6V output is shown in Figure 1-16. This circuit supplies a negative reference voltage across zener diode CR208 for the +6V series regulator.

An ac input voltage is supplied from constant voltage transformer T101 and is rectified by diodes CR216 and CR217. Capacitor C205 is used to filter this voltage. A constant base drive current is provided for Q207 by zener diode CR209 and R221. The Q207 collector current therefore provides a low ripple dc current source for zener diode CR208, which in turn provides a stable reference voltage for the +6V series regulator and the +6V overvoltage circuit.

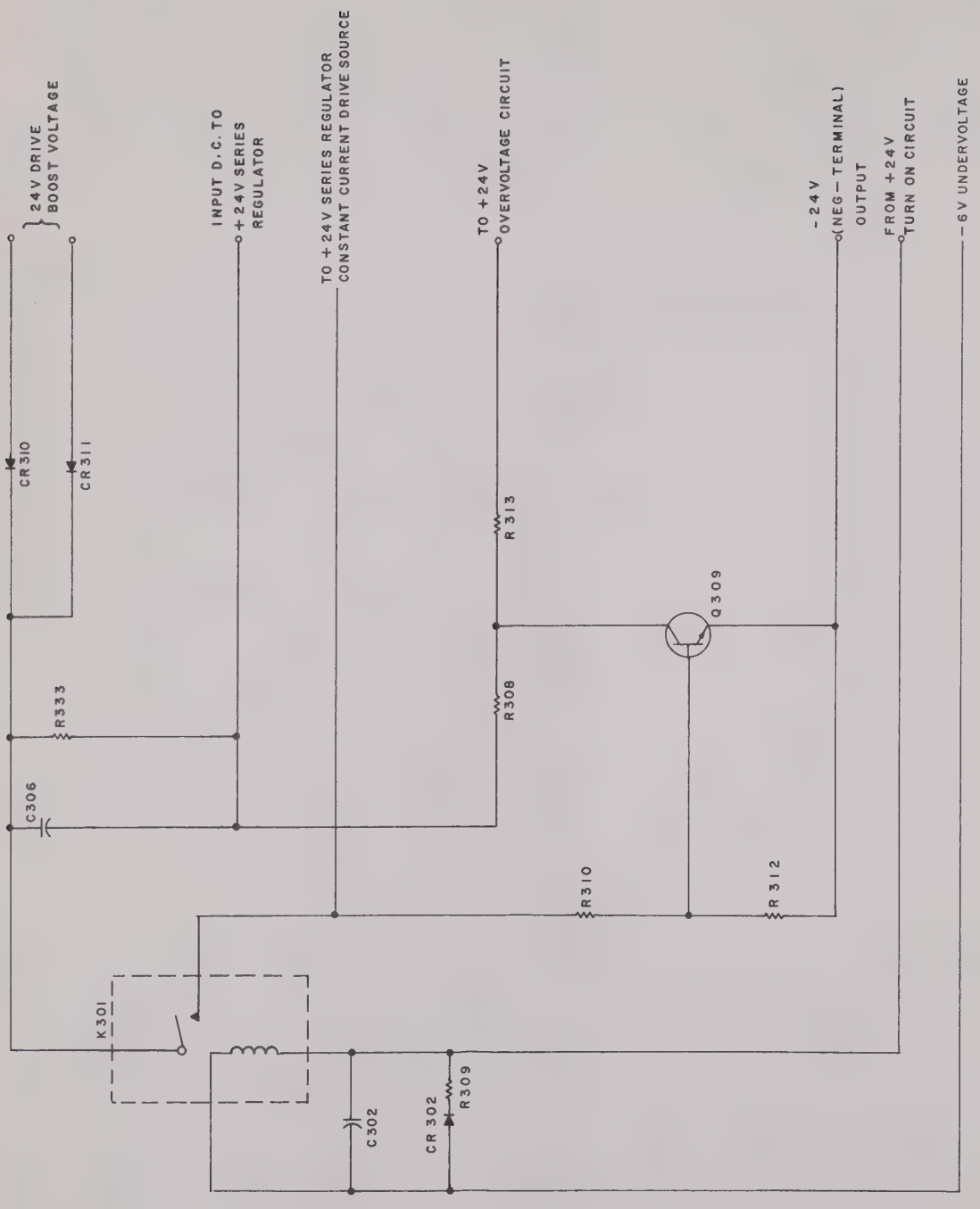


Figure 1-15. +24V Sequencing Circuit, Schematic Diagram

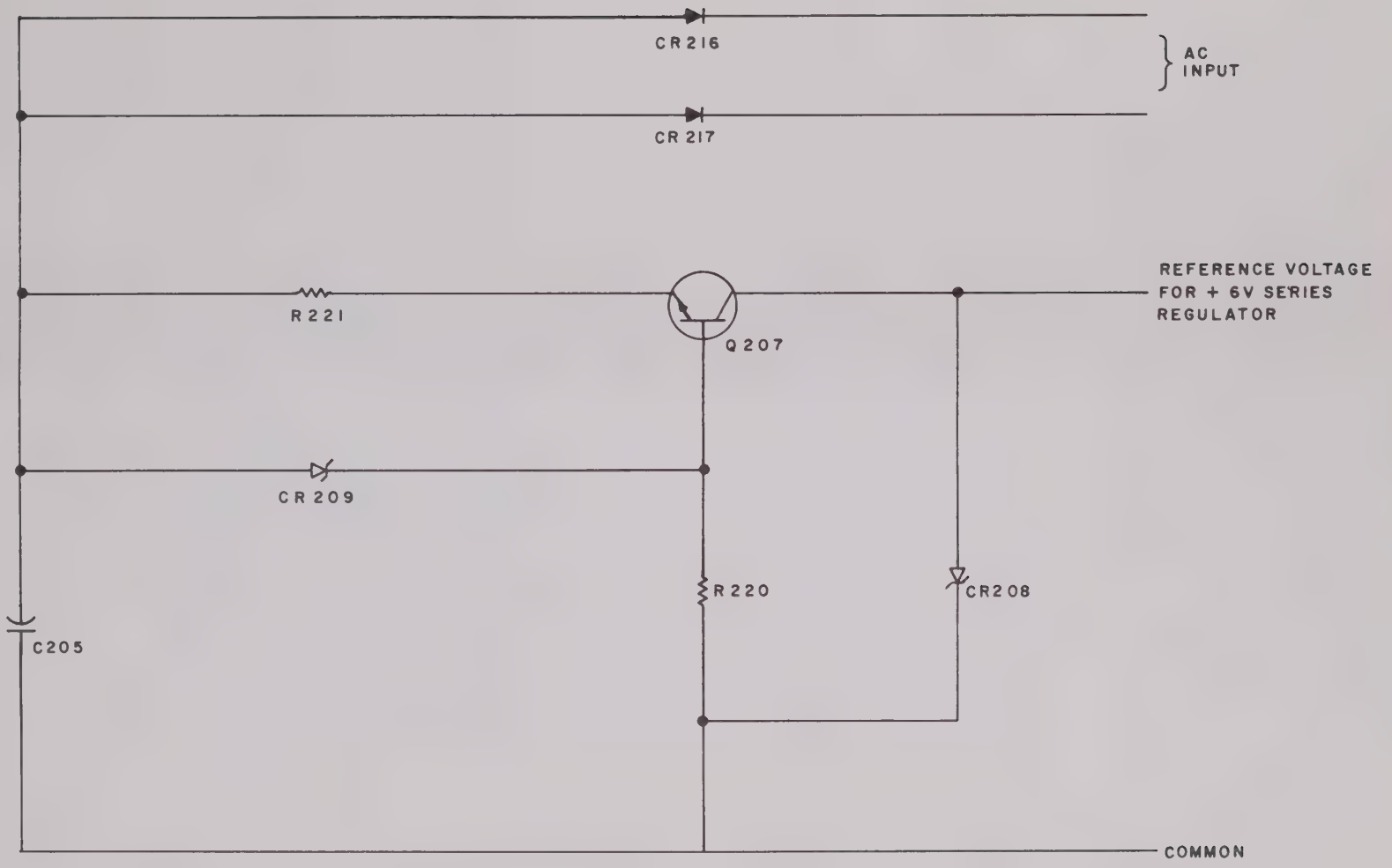


Figure 1-16. +6V Output Reference Voltage Circuit, Schematic Diagram

Reference Source Circuit for +24V Output

The reference source circuit for the +24V output (shown in Figure 1-17) provides a positive reference voltage across zener diode CR208 for the +24V series regulator.

An ac input voltage is supplied from constant voltage transformer T101 and is rectified by diodes CR306 and CR307. C304 is used to filter this voltage. A constant base drive current is provided for Q304 by zener diode CR305 and resistor R331. The collector current of Q304 supplies a low ripple dc current source for zener diode CR308, which provides a constant reference voltage for the +24V series regulator and the +24V overvoltage circuit.

-6V Undervoltage and +24V Turn-On Circuit

The -6V undervoltage circuit is shown in Figure 1-18. During turn-on of the power supply, this circuit prevents the +24V turn-on relay from energizing until both the +6V and -6V outputs have exceeded 90% of their nominal voltages.

A reference voltage determined by zener diode CR210 provides a constant current through R230 which holds Q209 on whenever this current exceeds R231 current. When the -6V output rises above 90% of nominal, the current through R231 exceeds the current through R230, and Q209 turns off. This allows R234 current to turn Q210 on, completing the 24V relay coil circuit and allowing the +24V output to turn on.

Line Sense and Fault Signal Circuit

The line sense and fault signal circuit is shown in Figure 1-19. A +4 to +6 volt fault signal is derived from the +6V output by R228 and CR213 whenever input ac voltage is above the minimum allowable line voltage. The line-sensing circuit removes the fault signal and turns the +24V output off whenever a low line condition occurs.

Input ac voltage appears across line sensing transformer T102. The secondary voltage of T102 is rectified by CR201 and CR202 to provide a dc voltage for use by the line sense circuit. A reference voltage across zener diode CR210 is derived from the input voltage to the +6V regulator by R224 and CR210. When line voltage drops below a predetermined level (low line), Q208 base voltage drops below this reference voltage, which turns Q208 on. Q208 then delivers a current through R226 and CR211 to the gate of silicon-controlled rectifier CR212. Firing this SCR grounds the fault signal. Grounding the fault signal also removes base drive to Q210 of the +24V turn-on circuit, which turns off the +24V output. R249 permits adjustment of the low line sensing point. R229 determines the impedance from the fault signal terminal to ground after the fault signal is removed.

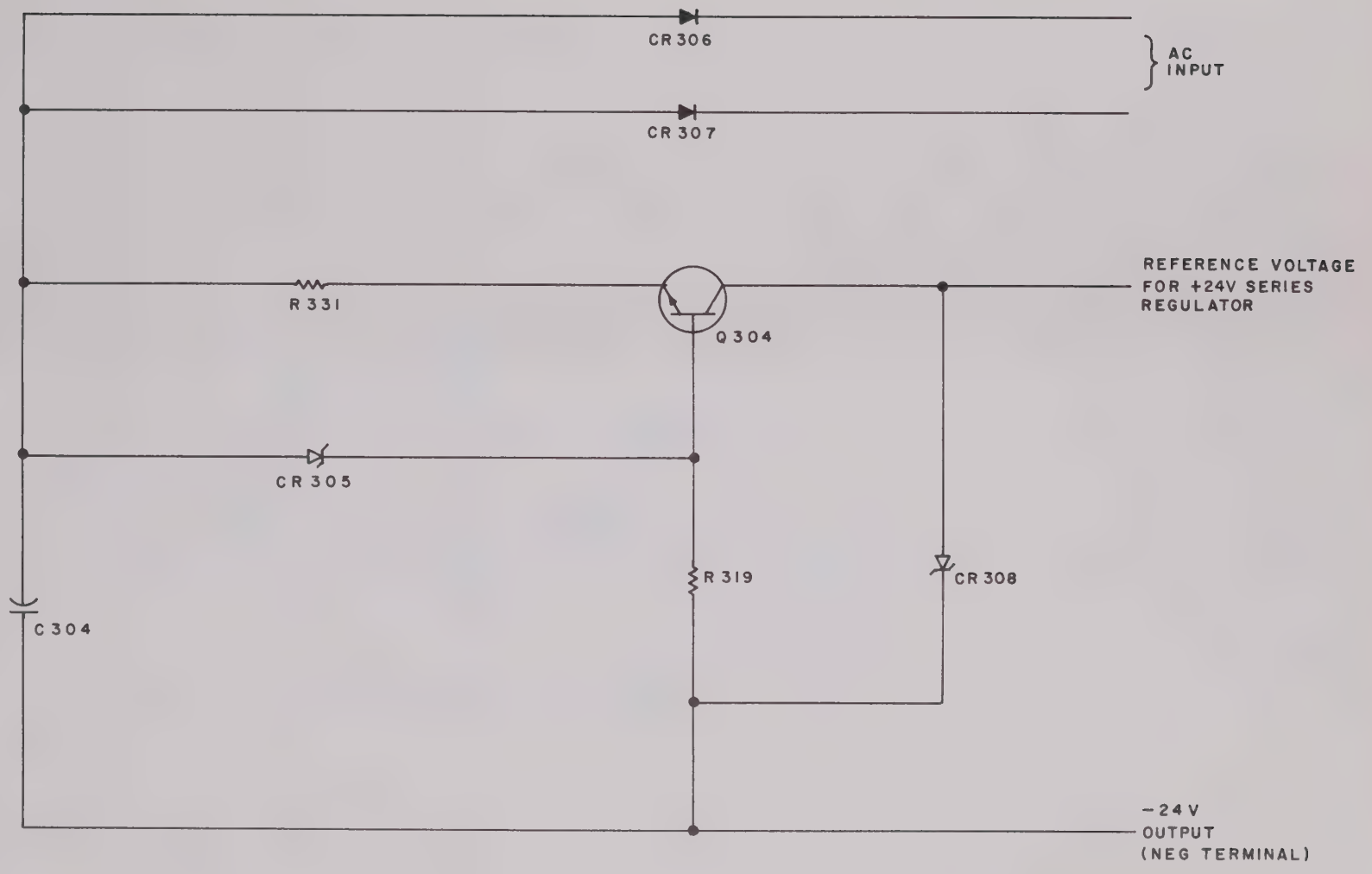


Figure 1-17. +24V Output Reference Voltage Circuit, Schematic Diagram

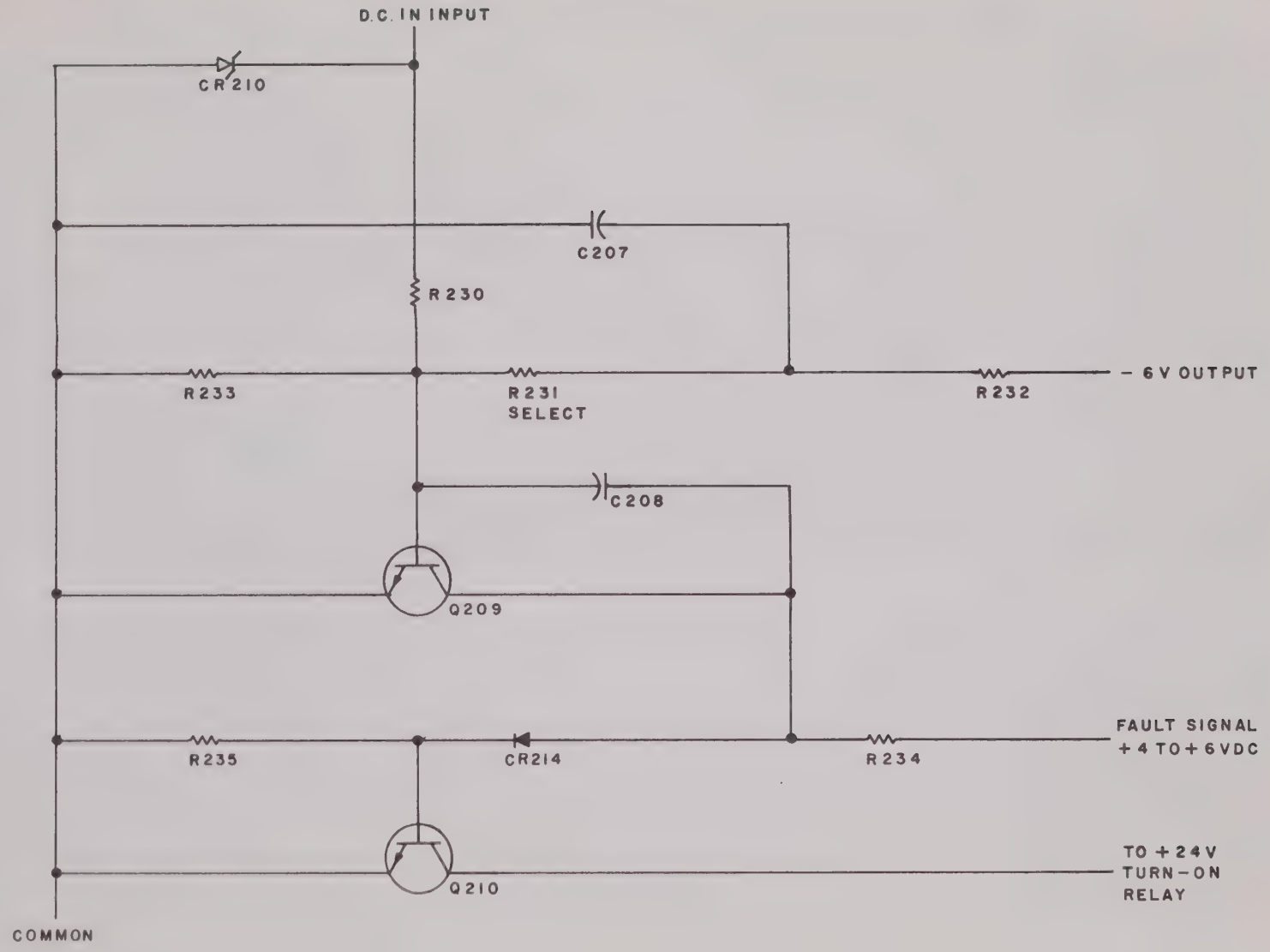


Figure 1-18. -6V Undervoltage and 24V Turn-On Circuit, Schematic Diagram

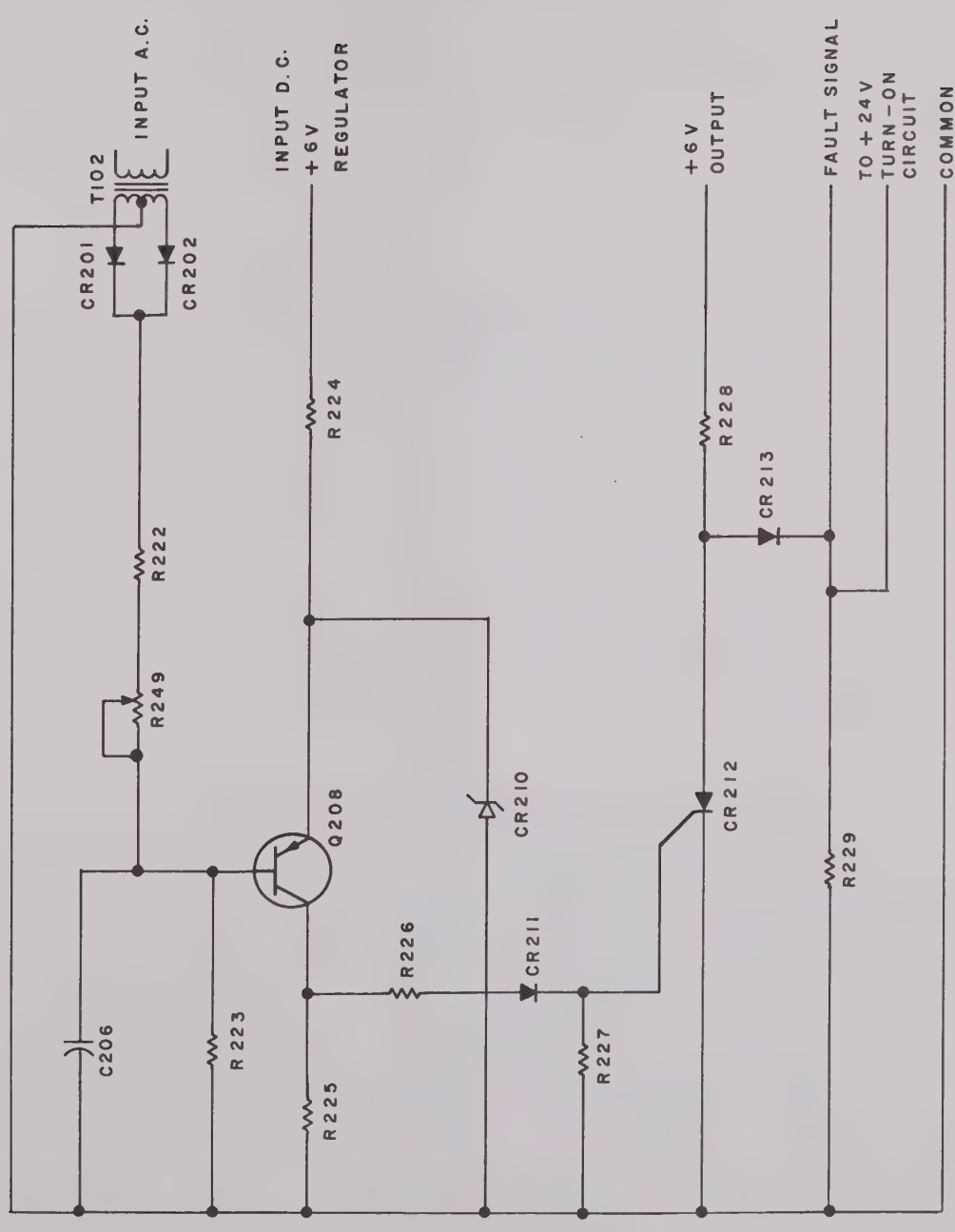


Figure 1-19. Line Sensing and Fault Signal Circuit, Schematic Diagram

MAINTENANCE

The MP-40 power supply has been designed to give trouble-free operation without routine maintenance. If any problems should occur, however, the following information will be helpful.

REPLACEMENT PARTS

Replacement parts can be purchased directly from Ault Incorporated. Most of the components are standard electronic parts and generally can be obtained more quickly locally. Several components, such as transformers and chokes, are manufactured by, or especially for, Ault Incorporated, and replacement parts should be ordered from the factory.

Care should be taken that the transistors and diodes are not replaced unless they are actually causing circuit malfunction. Care should also be exercised when soldering to transistors or rectifiers to prevent destruction of junctions by excessive heat.

Fuse Replacement

See Installation and Adjustment section of this manual.

SAFETY PRECAUTIONS

WARNING

Before troubleshooting or testing of the MP-40 power supply, the following precautions should be taken.

The chassis must be connected to system ground. The chassis is grounded through a stud on the rear panel. It is important that the input ac line be connected to system ground.

Before troubleshooting the supply, refer to the troubleshooting chart. When measurements must be made in the power supply, test instrument cases should be grounded.

CAUTION

All test equipment connections should be made with input power removed.

TROUBLESHOOTING

Initial Troubleshooting Procedure

Visually examine the supply, especially looking for burned or damaged parts, foreign matter, and loose leads.

Check fuses F101, F102, F103, F104, and F105 for continuity. If faulty replace with a fuse of the same type. (See Installation and Adjustment section of this manual.)

Recommended Test Equipment

The following test equipment is recommended for troubleshooting the MP-40 power supply:

a. DC voltmeter, 75 volts full scale.

b. AC voltmeter, 300 volts rms full scale.

c. Ohmeter, 1, 100, and 10,000 ohm scales.

A circuit card puller (No. 685-1081) and a circuit card extender (No. 180-1960), are available directly from Ault Incorporated.

Circuit Board Malfunctions

When troubleshooting the MP-40 power supply, circuit card malfunctions should be corrected by replacement of the defective plug-in card. An improperly corrected circuit card can damage the power supply.

Apparent circuit card malfunctions (Table 1-1, symptom 5) may be due to improper adjustment of one of the potentiometers. Circuit card adjustments are described in Installation and Adjustment section of this manual.

Table 1-1.
Troubleshooting Chart

	Symptom	Possible Causes
1.	No +6V or +24V output voltage. No fault signal. Low -6V output voltage.	a. Shorted capacitor: C108, C111, or C112 b. Shorted Rectifier: CR103, CR104, CR108 or CR109. c. Blown fuse: F102. * d. Open Resistor: R110
2.	No +6V, -6V or +24V output voltage. No fault signal.	a. Shorted capacitor: C101, C102, C103, C104 or C105. b. Blown fuse: F105. * c. Open thermostat: S102. ** d. External circuit breaker open. (See sympton No. 22.) ** e. Open choke: L101 (if the CVT tap connections are connected for 230 Vrms operation.

* Installation and Adjustment section
** Maintenance section

Table 1-1. (Cont)
Troubleshooting Chart

	Symptom	Possible Causes
3.	No +24V or -6V output voltage.	a. Shorted capacitor: C106, C107, C109 or C110. b. Shorted rectifier: CR107. c. Blown fuse: F103.* d. Open resistor: R122 e. Faulty rectifier assembly: A103.
4.	No +24V output voltage. No fault signal.	a. Transformer open or shorted: T102.
5.	No +24V output voltage.	a. Faulty circuit card: A101.** b. Shorted capacitor: C113, C114, C115, C116, or C117. c. Shorted rectifier: CR101, CR102, CR110, or CR111. d. Open transistor: Q107. e. Blown fuse: F101.*
6.	No +6V output voltage. No fault signal.	a. Open transistor: Q111.
7.	Low output voltage: +6V output.	a. Open rectifier: CR103 or CR104.
8.	Low output voltage: -6V output.	a. Faulty rectifier assembly: A103. b. Shorted transistor: Q112 or Q113,
9.	Low output voltage: +24V output.	a. Open rectifier: CR101 or CR102.
10.	Low output voltage, loss of regulation: +6V output.	a. Shorted transistor: Q108, Q109, Q110 or Q111.
11.	High output voltage, loss of regulation: +6V output.	a. Shorted transistor: Q108, Q109, Q110, or Q111.
12.	High output voltage, loss of regulation: +24V output.	a. Open transistor: Q112 or Q113. b. Open resistor: R122.
13.	High output voltage, loss of regulation: +24V output.	a. Shorted transistor: Q101 through Q107.
14.	High ripple: +6V output.	a. Open capacitor: C103, C104, C105, or C108.
15.	High ripple: -6V output.	a. Open capacitor: C106 or C107. b. Faulty rectifier assembly: A103.
16.	High ripple: +24V output	a. Open capacitor: C101, C102, C103, C104, or C113.

* Installation and Adjustment section
** Maintenance section

Table 1-1. (Cont)
Troubleshooting Chart

Symptom	Possible Causes
17. Oscillation of +6V output.	a. Open capacitor: C108.
18. Oscillation on -6V output.	a. Open capacitor: C107.
19. Oscillation on +24V output.	a. Open capacitor: C113.
20. Erratic over-voltage operation: +24V output.	a. Open resistor: R116.
21. Erratic over-voltage operation: +6V output.	a. Open resistor: R113.
22. External circuit breaker open.	a. Shorted capacitor: C118.
23. Noise and spikes on line.	a. Open capacitor: C118.
24. Bendback of +24V output occurs at one-half or proper values.	a. Open resistor: R108 or R109.
25. Fan inoperative.	a. Fuse blown: F104.*
26. Poor transient response: +6V output.	a. Open capacitor: C111 or C112.
27. Poor transient response: -6V output.	a. Open capacitor: C109 or C110.
28. Poor transient response: +24V output.	a. Open capacitor: C114, C115, C116, or C117.
29. Fuse F101 blown.	a. Faulty circuit card: A101.** b. Shorted transistor: Q101 through Q107.
30. Fuse F102 blown.	a. Faulty circuit card: A102.** b. Shorted transistor: Q108 through Q111.
31. Fuse F103 blown.	a. -6V output shorted.
32. Fuse F104 blown.	a. Faulty fan motor.
33. Fuse F105 blown.	a. Shorted transformer: T101.

* Installation and Adjustment section
** Maintenance section

Overloaded Supply

If power supply overloading is suspected, remove connections to the load. If the supply then regulates, it was being operated above its overcurrent setting.

Power Supply Overheating

If the power supply becomes overheated, thermostat S102 will open. Check to see that proper cooling air is supplied to the power supply. (See Installation and Adjustment section.)

ELECTRICAL PARTS LIST

Electrical parts are listed in the following table. Detailed diagrams (Figures 1-20 through 1-23 follow the listing.

Electrical Parts List, Model MP-40/MP-40E

Ref. Desig.	Description	Ault Part No.
	PR36-A2 or PR36-B1 Power Supply	
A101	CIRCUIT CARD ASSY: +24 Control	080-2409
A102	CIRCUIT CARD ASSY: ±6 Control	080-2410
A103	DIODE ASSY, SDA-10121	606-1031
B101	FAN, MUFFIN	628-1001
C101, 102	CAPACITOR: 5 μF, 660V	406-1312
C103, 104	CAPACITOR: 22,000 μF, 50V	400-1272
C105	CAPACITOR: 48,000 μF, 20V	400-1269
C106	CAPACITOR: 38,000 μF, 10V	400-1362
C107, 108	CAPACITOR: 5,000 μF, 10V	400-1243
C109, 110, 111 112	CAPACITOR: 100 μF, 10V	404-1045
C113	CAPACITOR: 1,200 μF, 50V	400-1244
C114, 115, 116, 117	CAPACITOR: 33 μF, 35V	404-1039
C118	CAPACITOR: 2 μF, 400V	406-1216
CR101, 102	DIODE: (Rectifier) Replacement type 40211	603-1200
CR103, 104	DIODE: (Rectifier) Replacement type 40109	603-1194

Ref. Desig.	Description	Ault Part No.
CR107	DIODE: (Rectifier) Replacement type 40208	603-1198
CR108	DIODE, SCR: Replacement type C30F	
CR109	DIODE: (Rectifier) Replacement type 40208	603-1029
CR110	DIODE: (Rectifier) Replacement type 40209	603-1029
CR111	DIODE, SCR: Replacement type C30F	
DS101	LAMP: GE WE51	626-1007
F101	FUSE: 20 amp	622-1095
F102	FUSE: 15 amp	622-1086
F103	FUSE: 5 amp	622-1085
F104	FUSE: 1/4 amp	622-1092
F105	FUSE: 15 amp (use 8 amp for 230V operation)	622-1086
L101	COIL: (PR36-A2 only)	302-1219
	COIL: (PR36-B1 only)	302-1221
Q101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111	TRANSISTOR: Replacement type 2N3055	601-1131
Q112	TRANSISTOR: Replacement type 2N3054	601-1161
Q113	TRANSISTOR: Replacement type 2N3055	601-1131
R101, 102, 103, 104, 105, 106	RESISTOR, WW: 0.25 ohm, ±10%, 10W	580-2359
R107	RESISTOR, WW: 250 ohms ±5%, 5W	580-4123
R108,109,110	RESISTOR, WW: 0.1 ohm, ±10%, 25W	580-6601
R111	RESISTOR, WW: 0.1 ohm, ±10%, 10W	580-5360
R112	RESISTOR, WW: 250 ohms ±5%, 20W	580-5758
R113	RESISTOR, CC: 200 ohms ±5%, 1/2W	500-1071
R114	RESISTOR, WW: 0.1 ohm ±10%, 10W	580-5360
R115	RESISTOR, WW: 0.25 ohm ±10%, 10W	580-5359
R116	RESISTOR, WW: 200 ohms ±5%, 1/2W	500-1071
R117, 118, 119	RESISTOR, WW: 0.25 ohm ±10%, 10W	580-5359
R120	RESISTOR, MF: 28.7K ±1%, 1/2W	530-2402

Ref. Desig.	Description	Ault Part No.
R121	RESISTOR, MF: 7.15K ±1%, 1/2W	530-2401
R122	RESISTOR, WW: 0.5 ohm ±5%, 25W	580-6546
R123	RESISTOR, CC: 1K ±5%, 2W	500-3088
S101	SWITCH, TOGGLE:	626-1031
S102	SWITCH (Thermostat)	626-1092
S103	SWITCH, WAFER	626-1022
T101	TRANSFORMER: (PR36-A2 only)	301-1209
	TRANSFORMER: (PR36-B1 only)	301-1214
T102	TRANSFORMER: (PR36-A2 only)	301-1172
	TRANSFORMER: (PR36-B1 only)	301-1253
	+24V Control Card Assy 080-2409	
C301	CAPACITOR: 0.0022 μF, 200V	406-1136
C302	CAPACITOR: 5 μF, 25V	400-1073
C303	CAPACITOR: 0.01 μF, 200V	406-1133
C304	CAPACITOR: 50 μF, 25V	400-1078
C305	CAPACITOR: 0.0022 μF, 200V	406-1136
C306	CAPACITOR: 50 μF, 25V	400-1078
CR301, 302, 303, 304	DIODE: Replacement type 1N645	603-1171
CR305	DIODE, ZENER: Replacement type VR6A	605-1171
CR306,307	DIODE: Replacement type 1N645	603-1171
CR308	DIODE, ZENER: Replacement type 1N2163	605-1031
CR309	DIODE, ZENER: Replacement type VR6A	605-1171
CR310, 311, 312	DIODE: Replacement type 1N645	603-1171
K301	RELAY - REED	624-1102
Q301, 302	TRANSISTOR: Replacement type H204	601-1081
Q303	TRANSISTOR: Replacement type 2N3440	601-1171
Q304	TRANSISTOR: Replacement type 2N697	601-1051
Q305	TRANSISTOR: Replacement type H204	601-1081

Ref. Desig.	Description	Ault Part No.
Q306, 307, 308, 309	TRANSISTOR: Replacement type 2N697	601-1051
Q310	TRANSISTOR: Replacement type H204	601-1081
R301	RESISTOR, CC: 91 ohms ±5%, 1/2W	500-1063
R302, 303	RESISTOR; CC: 10K ±5%, 1/2W	500-1112
R304	RESISTOR, CC: 2K ±5%, 1/2W	500-1095
R305	RESISTOR, CC: (Value tailored to circuit) ±5%, 1/2W	500-XXXX
R306	RESISTOR, CC: 16K ±5%, 1/2W	500-1117
R307	RESISTOR, CC: 1K ±5%, 1/2W	500-1088
R308	RESISTOR, CC: 7.5K ±5%, 1/2W	500-1109
R309	RESISTOR, CC: 510 ohms ±5%, 1/2W	500-1081
R310	RESISTOR, CC: 20K ±5%, 1/2W	500-1119
R311	RESISTOR, CC: 1.2K ±5%, 1/2W	500-1090
R312	RESISTOR, CC: 5.1K ±5%, 1/2W	500-1105
R313	RESISTOR, CC: 6.2K ±5%, 1/2W	500-1107
R314	RESISTOR, CC: 10K ±5%, 1/2W	500-1112
R315	RESISTOR, CC: 470K ±5%, 1/2W	500-1152
R316	RESISTOR, CC: 1.8K ±5%, 1/2W	500-1094
R317	RESISTOR, CC: 10 ohms ±5%, 1/2W	500-1040
R318	RESISTOR, MF: 2.21K ±1%, 1W	530-3303
R319	RESISTOR, CC: 3K ±5%, 1/2W	500-1099
R320	RESISTOR, MF: 910 ohms ±5%, 1W	530-3087
R321	RESISTOR, CC: 3.9K ±5%, 1/2W	500-1102
R322	RESISTOR, CC: (Value tailored to circuit) ±5%, 1/2W	500-XXXX

Electrical Parts List, Model MP-40/MP-40E (Cont)

Ref. Desig.	Description	Ault Part No.
R323	RESISTOR, CC: 300 ohms ±5%, 1/2W	500-1075
R324	RESISTOR, CC: 3.9 ohms ±5%, 1W	500-2102
R325	RESISTOR, CC: 1K ±5%, 1/2W	500-1088
R326	RESISTOR, POTENTIOMETER: 1K, 1/2W	590-1088
R327	RESISTOR, CC: 430 ohms ±5%, 1/2W	500-1079
R328	RESISTOR, CC: 10K ±5%, 1/2W	500-1112
R329, 330	RESISTOR, MF: 500 ohms ±1%, 1W	580-1053
R331	RESISTOR, CC: 270 ohms ±5%, 1/2W	500-1074
R332	RESISTOR, CC: 100 ohms ±5%, 1/2W	500-1064
R333	RESISTOR, CC: 10K ±5%, 1/2W	500-1112
R334	RESISTOR, MF: 2K ±1%, 1W	530-3302
R335	RESISTOR, CC: 10K ±5%, 1/2W	500-1112
	±6 Control Card Assy 080-2410	
C201, 202	CAPACITOR: 0.01 µF, 200V	406-1133
C203	CAPACITOR: 50 µF, 25V	400-1073
C204	CAPACITOR: 100 µF, 12V	400-1054
C205	CAPACITOR: 50 µF, 25V	400-1073
C206	CAPACITOR: 1.5 µF, 35V	404-1036
C207	CAPACITOR: 5 µF, 12V	400-1083
C208	CAPACITOR: 0.01 µF, 200V	406-1133
C209	CAPACITOR: 2 µF, 25V	400-1065
C210	CAPACITOR: 0.01 µF, 200V	406-1133

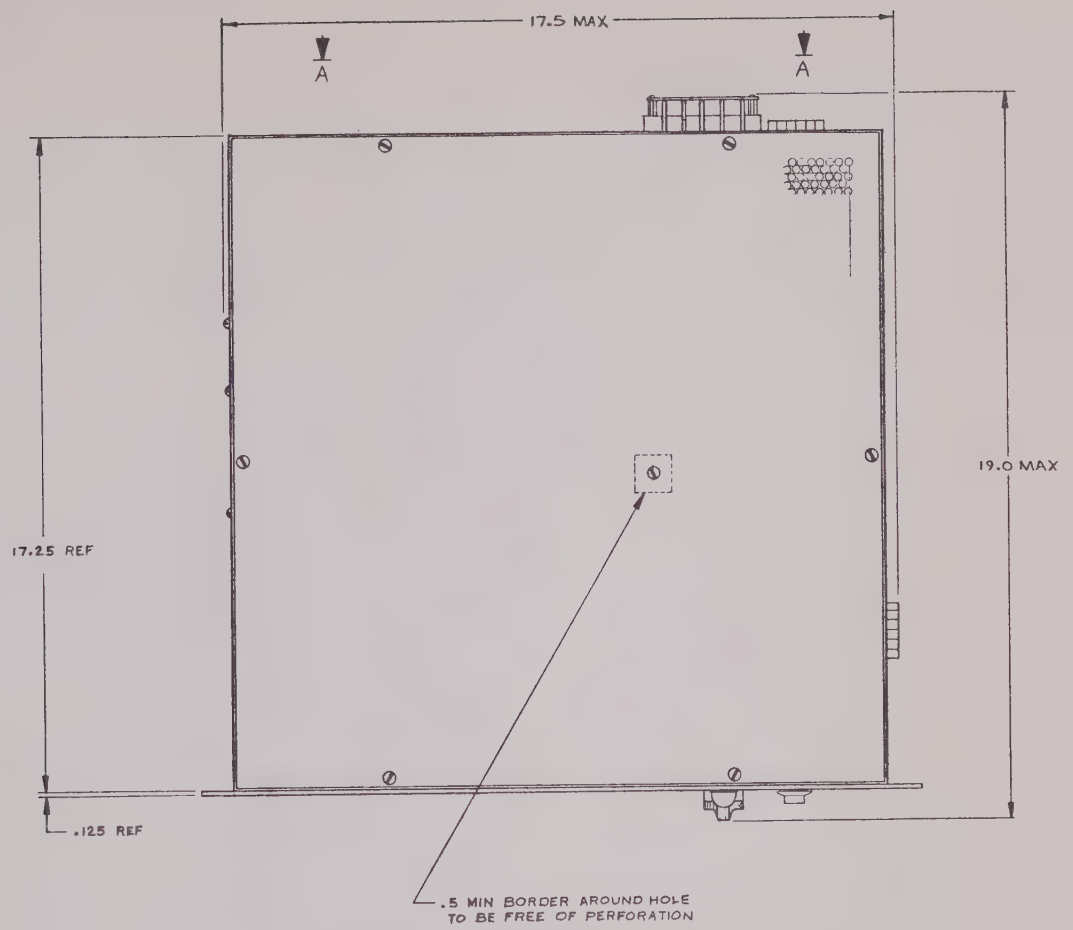
Ref. Desig.	Description	Ault Part No.
CR201, 202	DIODE: Replacement type 1N648	603-1172
CR203	DIODE: Replacement type 1N645	603-1171
CR204	DIODE, ZENER: Replacement type VR6A	605-1171
CR205, 206, 207	DIODE: Replacement type 1N645	603-1171
CR208	DIODE, ZENER: Replacement type 1N2163	605-1031
CR209, 210,	DIODE, ZENER: Replacement type VR6A	605-1171
CR211	DIODE: Replacement type 1N645	603-1171
CR212	DIODE, SCR: Replacement type C6F	600-1065
CR213, 214, 215, 216, 217, 218, 219	DIODE: Replacement type 1N645	603-1171
Q201, 202	TRANSISTOR: Replacement type H204	601-1081
Q203	TRANSISTOR: Replacement type 2N3638	601-1151
Q204	TRANSISTOR: Replacement type 2N697	601-1051
Q205, 206	TRANSISTOR: Replacement type ME4002	601-1146
Q207	TRANSISTOR: Replacement type 2N697	601-1051
Q208	TRANSISTOR: Replacement type H204	601-1081
Q209	TRANSISTOR: Replacement type ME4002	601-1146
Q210	TRANSISTOR: Replacement type 2N697	601-1051
Q211	TRANSISTOR: Replacement type ME4002	601-1146
Q212, 213	TRANSISTOR: Replacement type 2N3638	601-1151
Q214	TRANSISTOR: Replacement type ME4002	601-1146
Q215	TRANSISTOR: Replacement type 2N3638	601-1151
R201	RESISTOR, CC: 110 ohms ±5%, 1/2W	500-1065
R202	RESISTOR, CC: 620 ohms ±5%, 1/2W	500-1083
R203	RESISTOR, CC: 10K ±5%, 1/2W	500-1112
R204	RESISTOR, CC: (Value tailored to circuit) ±5%, 1/2W	500-XXXX
R205	RESISTOR, CC: 620 ohms ±5%, 1/2W	500-1083
R206	RESISTOR, CC: 430 ohms ±5%, 1/2W	500-1079
R207	RESISTOR, CC: 150 ohms ±5%, 1/2W	500-1068
R208	RESISTOR, CC: 10K ±5%, 1/2W	500-1112

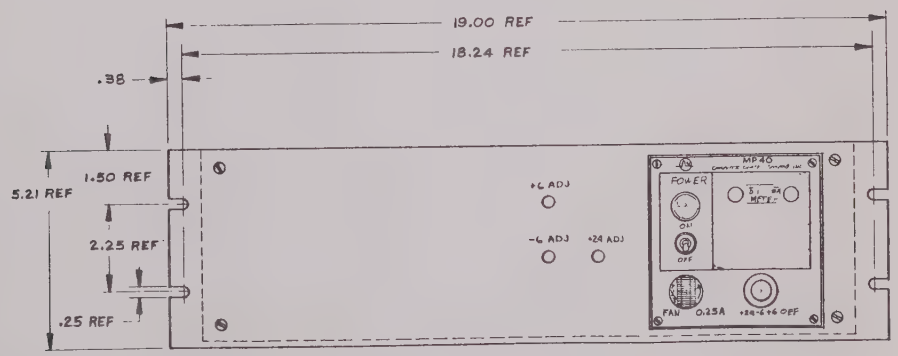
Electrical Parts List, Model MP-40/MP-40E (Cont)

Ref. Desig.	Description	Ault Part No.
R209	RESISTOR, CC: 470 ohms ±5%, 1/2W	500-1080
R210	RESISTOR, CC: 214K ±5%, 1/2W	500-1097
R211	RESISTOR, CC: 470 ohms ±5%, 1/2W	500-1080
R212	RESISTOR, CC: 6.8K ±5%, 1/2W	500-1108
R213, 214	RESISTOR, CC: 1K ±5%, 1/2W	500-1088
R215	RESISTOR, CC: 470K ±5%, 1/2W	500-1152
R216	RESISTOR, POTENTIOMETER: 500 ohms, 1/2W	590-1086
R217	RESISTOR, MF: 620 ohms ±5%, 1/2W	500-2083
R218	RESISTOR, MF: 1.3K ±5%, 1/2W	530-2091
R219	RESISTOR, MF: 680 ohms ±5%, 1/2W	530-2084
R220	RESISTOR, CC: 2.4K ±5%, 1/2W	500-1097
R221	RESISTOR, CC: 270 ohms ±5%, 1/2W	500-1074
R222	RESISTOR, CC: 12K ±5%, 1/2W	500-1114
R223	RESISTOR, CC: 3K ±5%, 1/2W	500-1099
R224	RESISTOR, CC: 560 ohms ±5%, 1/2W	500-1082
R225	RESISTOR, CC: 20K ±5%, 1/2W	500-1119
R226	RESISTOR, CC: 3K ±5%, 1/2W	500-1099
R227	RESISTOR, CC: 1K ±5%, 1/2W	500-1088
R228	RESISTOR, WW: 25 ohms ±5%, 3W	580-2762
R229	RESISTOR, CC: 200 ohms ±5%, 1/2W	500-1071
R230	RESISTOR, CC: 2.4K ±5%, 1/2W	500-1097
R231	RESISTOR, CC: (Value tailored to circuit) ±5%, 1/2W	500-XXXX

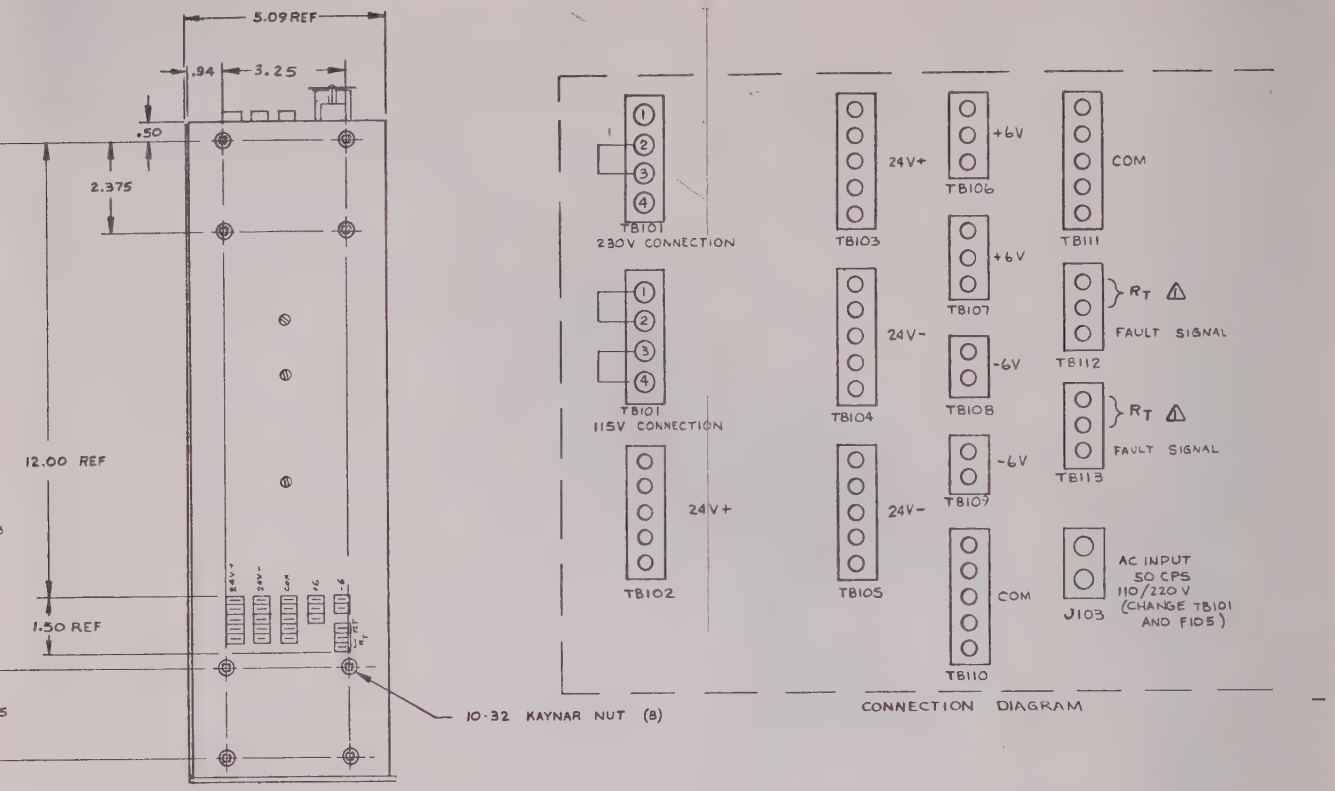
Electrical Parts List, Model MP-40/MP-40E (Cont)

Ref. Desig.	Description	Ault Part No.
R232	RESISTOR, CC: 1K ±5%, 1/2W	500-1088
R233	RESISTOR, CC: 20K ±5%, 1/2W	500-1119
R234	RESISTOR, CC: 1K ±5%, 1/2W	500-1088
R235	RESISTOR, CC: 5.1K ±5%, 1/2W	500-1105
R236	RESISTOR, CC: 16K ±5%, 1/2W	500-1117
R237	RESISTOR, CC: 10K ±5%, 1/2W	500-1112
R238	RESISTOR, CC: (Value tailored to circuit) ±5%, 1/2W	500-XXXX
R239	RESISTOR, CC: 1K ±5%, 1/2W	500-1088
R240	RESISTOR, CC: 100 ohms ±5%, 1/2W	500-1064
R241	RESISTOR, MF: 560 ohms ±5%, 1/2W	530-2082
R242	RESISTOR, POTENTIOMETER: 200 ohms, 1/2W	590-1087
R243	RESISTOR, CC: 1K ±5%, 1/2W	500-1088
R244	RESISTOR, CC: 5.1K ±5%, 1/2W	500-1105
R245	RESISTOR, CC: 10K ±5%, 1/2W	500-1112
R246	RESISTOR, CC: 1K ±5%, 1/2W	500-1088
R247	RESISTOR, CC: 100 ohms ±5%, 1/2W	500-1064
R248	RESISTOR, CC: 2K ±5%, 1/2W	500-1095
R249	RESISTOR, POTENTIOMETER: 5K, 1/2W	590-1090





⚠-CONNECT A THERMISTOR (3C PART NO. 932 300 004) TO EITHER OF THE R_T TERMINALS BEFORE OPERATING.



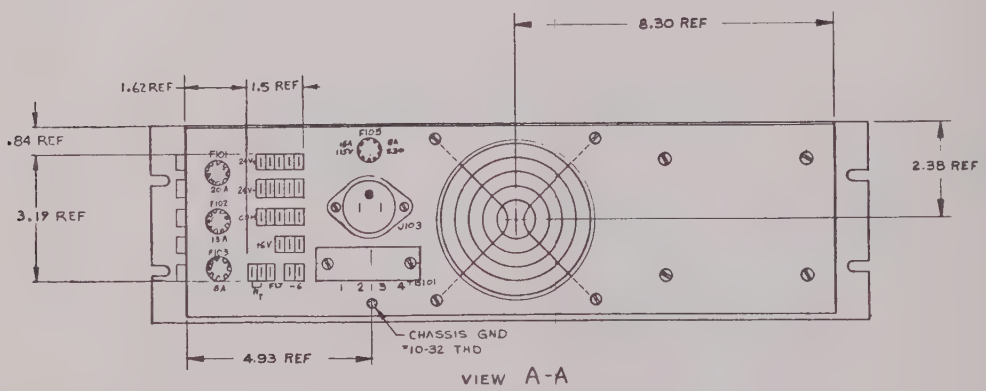
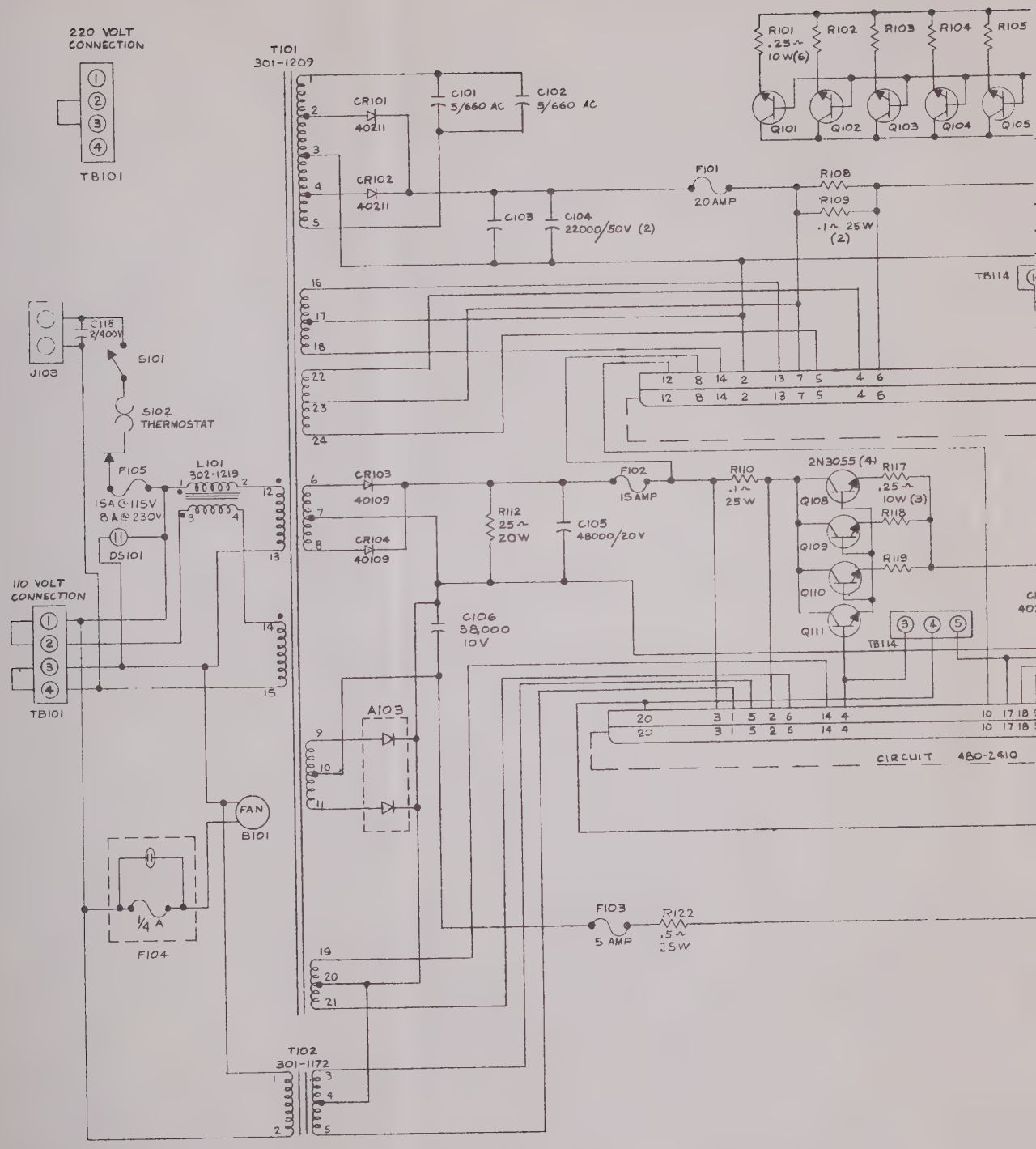


Figure 1-20. Power Supply, Model MP-40/MP-40E, Installation (PR36-A2-1)



1-ALL RESISTANCES ARE ½W IN OHMS & ALL CAPACITANCES ARE IN UF UNLESS OTHERWISE SPECIFIED.

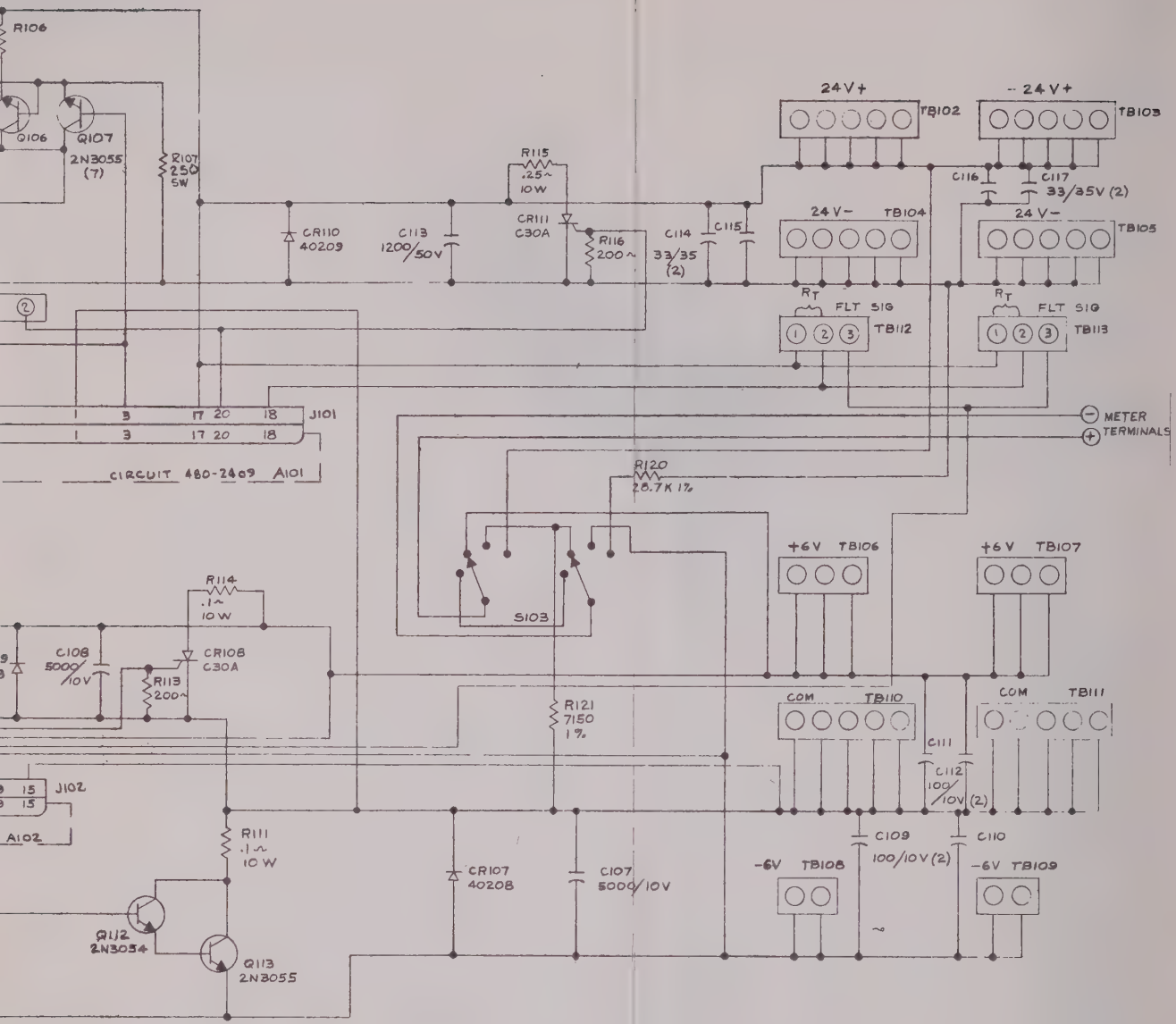
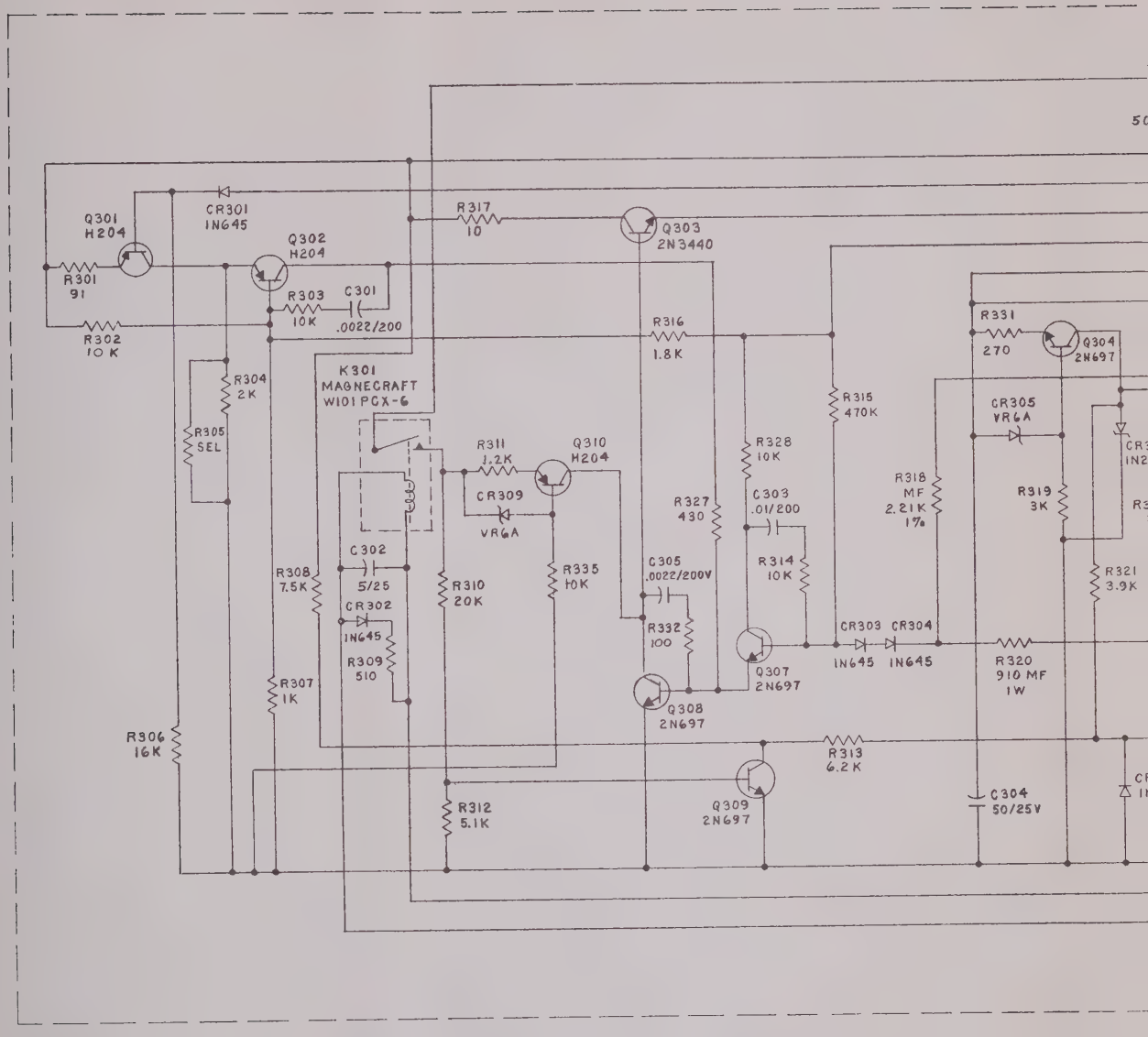


Figure 1-21. MP-40 Power Circuit, 60 Hz Schematic Diagram (PR36-A2-2)



1. ALL RESISTANCES 1/2 W IN OHMS AND ALL CAPACITANCES ARE IN UF UNLESS OTHERWISE SPECIFIED

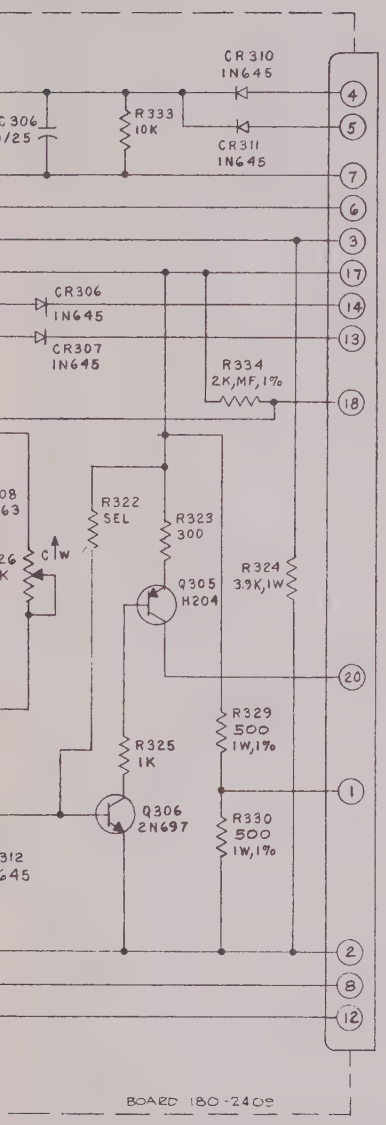
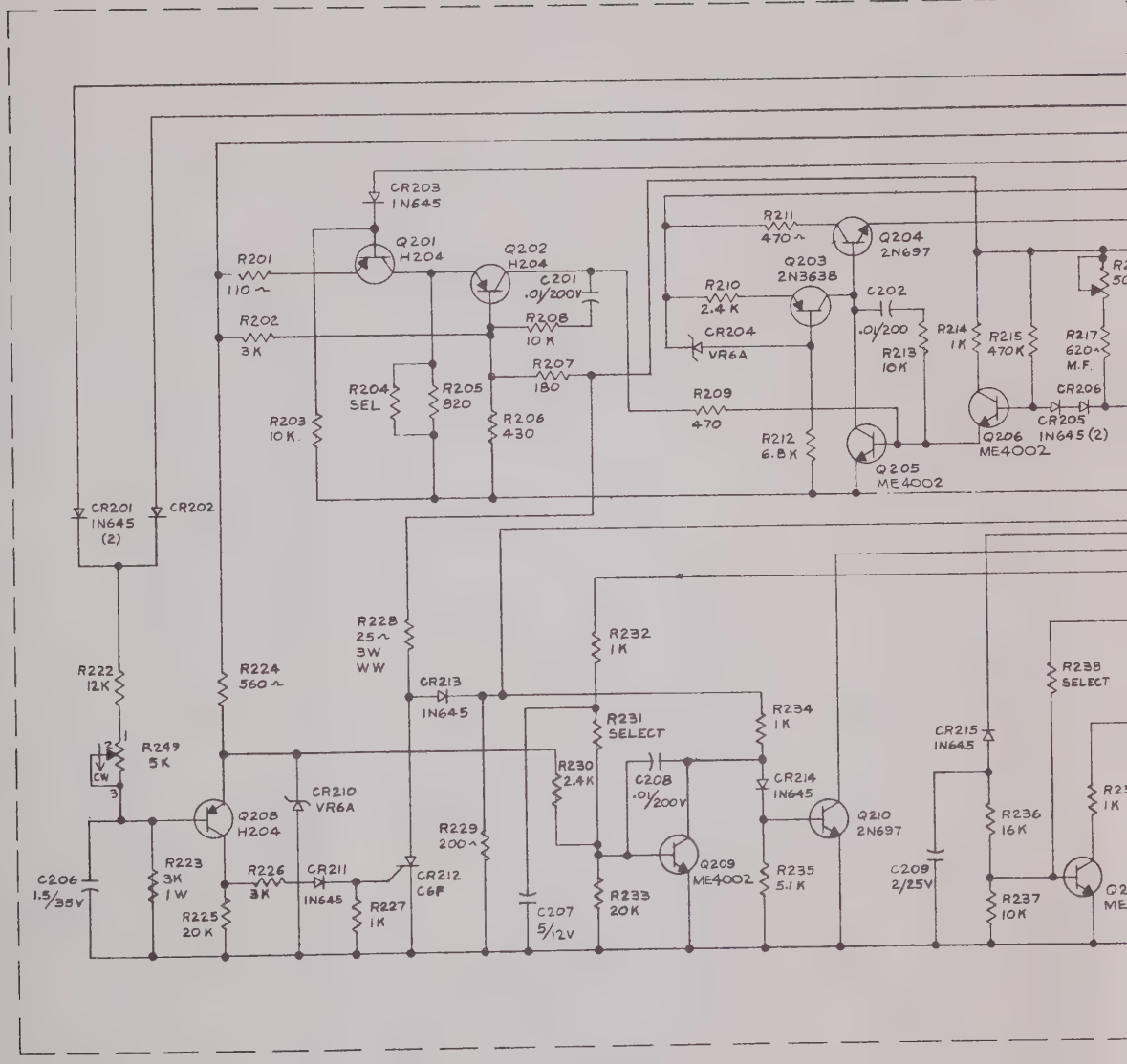


Figure 1-22. +24V Control Circuit, Schematic Diagram (480-2409)



1- ALL RESISTANCES 1/2W IN OHMS AND ALL CAPACITANCES ARE IN UF UNLESS OTHERWISE SPECIFIED.

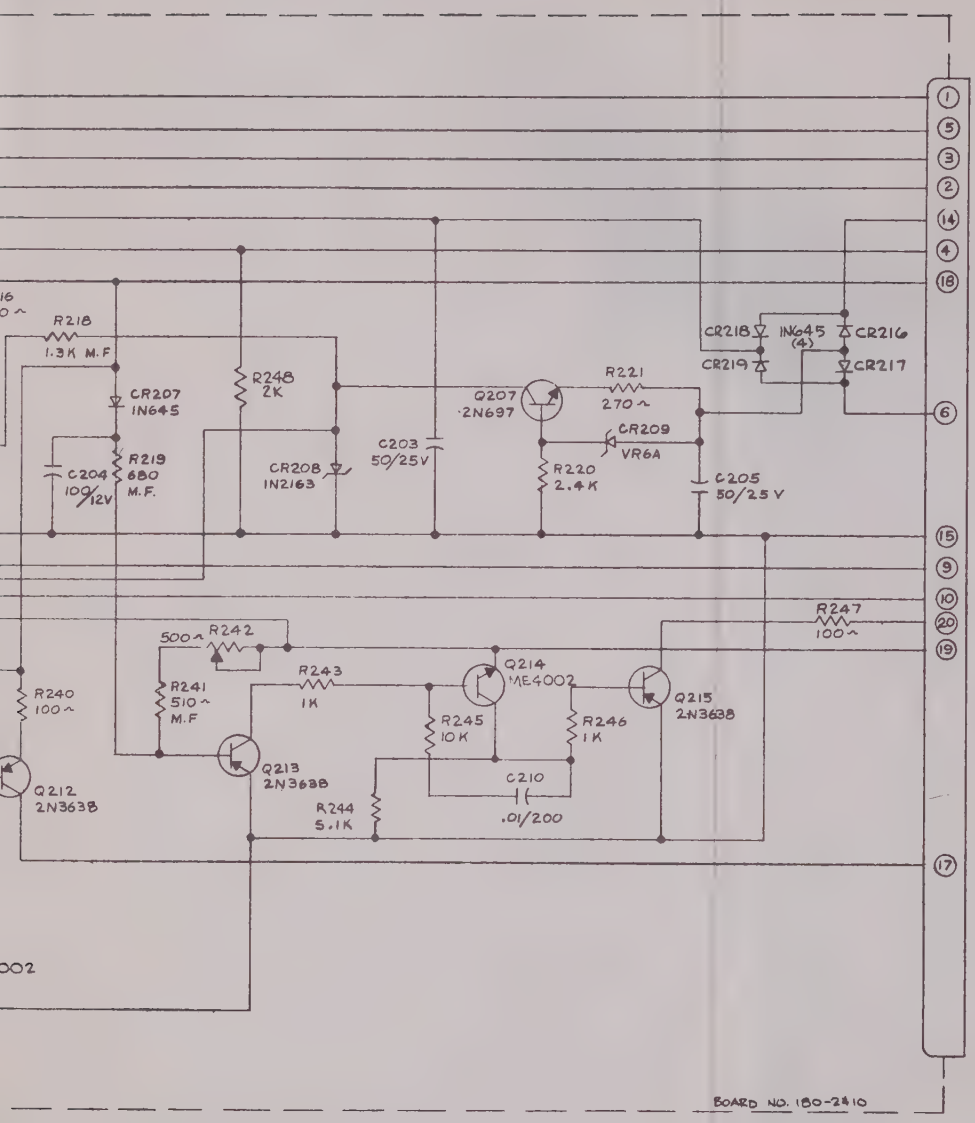


Figure 1-23. ±6V Control Circuit, Schematic Diagram (480-2410)

PART I

SECTION II
MP-40/40E POWER SUPPLY (AULT)*

INTRODUCTION

This section contains the information needed for installation, adjustment, operation, and maintenance of the MP-40 (PR36-C1, Serial No. 195 and above) and MP-40E (PR36-D1, Serial No. 31 and above) power supplies. The MP-40 and MP-40E are identical multiple-output power supplies except for input power requirements. The MP-40 is designed to operate at 60 ±1 Hz, and the MP-40E is designed to operate at 50 ±1 Hz. The power transformer (T101) and line sense transformer (T102) are the only components that differ between the two devices.

NOTE

This section should be read thoroughly before operating the equipment.

REFERENCED DRAWINGS

The following diagrams are included at the end of this manual.

Drawing No.	Figure No.	Title
PR36-A1 PR36-C1-1	1-43 (Sheet 1 of 2)	Power Supply Model MP-40/ MP-40E Installation
PR36-B1 PR36-D1-1	(Sheet 2 of 2)	
PR36-C1-2 PR36-D1-2	1-44 (Sheet 1 of 2) (Sheet 2 of 2)	MP-40/MP-40E Power Circuit Schematic
480-2461	1-45	+24V Control Circuit Schematic (480-2461)
480-2457	1-46	±6V Control Circuit Schematic (480-2457)

Component reference numbers in the 100 series (i.e., R101, CR102, etc.) refer to components shown in Circuit Diagram PR36-C1-2 (or PR36-D1-2). Reference numbers in the 200 series refer to components shown in Circuit Diagram 480-2457. Reference numbers in the 300 series refer to components shown in Circuit Diagram 480-2461.

MECHANICAL DESCRIPTION

The top cover of the MP-40 power supply is easily removed to provide access to power supply components. All high-power dissipating components are mounted on heat sinks. Low-power control components are mounted on two etched circuit boards.

*The information in this section is presented with the permission of the manufacturer, Ault, Incorporated, 3501 48th Avenue North, Minneapolis, Minnesota, 55429.

The MP-40 power supply can be mounted either horizontally or vertically. The normal horizontal configuration is designed for standard 19-inch rack mounting. Removal of the front panel and rotating the meter panel 90 degrees allows vertical mounting of the power supply.

ELECTRICAL DESCRIPTION

A complete description of the operation of the MP-40 power supply has been provided previously in this manual. Briefly, the MP-40 power supply provides three regulated dc outputs which are isolated from the chassis and from input ac line voltage. Nominal values of these voltages are +24 Vdc, +6 Vdc, and -6 Vdc.

The power supply provides turn-on and turn-off sequencing, overload protection, overvoltage protection, and overtemperature protection. Overtemperature or low-line conditions will shut down the power supply. Overload or overvoltage conditions will drop the affected output to a low voltage.

Magnetic Components

Components T101 and T102 will be different for 60 Hz and 50 Hz operation. Part numbers for the appropriate components are:

Reference No.	MP-40 (60 Hz)	MP-40E (50 Hz)
T101	301-1306	301-1338
T102	301-1172	301-1253

Special Testing Equipment

A circuit card puller (No. 685-1081) and a circuit card extender (No. 180-1960) are available directly from Ault Incorporated.

INSTALLATION AND ADJUSTMENT

UNPACKING

Care should be used when unpacking the MP-40 power supply. Inspection for physical damage should be made on arrival.

INSTALLATION PROCEDURE

Mounting

Provisions have been made, as specified by Honeywell Computer Control Division, for mounting the MP-40 power supply.

External Connections

(See installation drawing Figure 1-43.) All external connections are made through terminal strips TB101 through TB113, connector J103 and a chassis ground stud (located on the rear panel).

Terminal	
1	Connect to terminal 2 of TB101 for 95-130 volts input.
	Terminal 1 is not connected for 190-260 volts input.
2	Connect to terminal 1 of TB101 for 95-130 volts input.
	Connect to terminal 3 of TB101 for 190-260 volts input.
3	Connect to terminal 4 of TB101 for 95-130 volts input.
	Connect to terminal 2 of TB101 for 190-260 volts input.
4	Connect to terminal 3 of TB101 for 95-130 volts input.
	Terminal 4 is not connected for 190-260 volts input.
TB102	24V output, + terminal
TB103	24V output, + terminal
TB104	24V output, - terminal
TB105	24V output, - terminal
TB106	6V output, + terminal
TB107	6V output, + terminal
TB108	6V output, - terminal
TB109	6V output, - terminal
TB110	±6V common
TB111	±6V common

Terminal	
TB112-1	Temperature programming resistor
TB112-2	Temperature programming resistor
TB112-3	Fault signal
TB113-1	Temperature programming resistor
TB113-2	Temperature programming resistor
TB113-3	Fault signal
J103	Input ac power

Transformer Tap Connections

NOTE

Transformer tap connections at TB101 must be correct before input power is applied. Refer to the preceding paragraph for the necessary connections.

External Temperature Sense Connections

To operate the power supply, a thermistor (Ferroxcube No. B832007P/4K7S, 3C Part No. 932 300 004) must be connected across the R_T terminals of TB112 or TB113. The thermistor should be connected at the same location as the load connection.

Chassis Ground

NOTE

To insure safety of operating personnel, the chassis must be connected to system ground using the 10-32 threaded stud on the rear panel.

Fuse Protection

NOTE

Fuse F105 must be changed when converting from 115V to 230V operation. F105 is a standard glass fuse rated at 15 amperes at 115V or 8 amperes at 230V. Fuses F101, F102, and F103 are standard glass fuses and provide overcurrent protection. Fuse F104 protects the fan motor against excessive current. F101 is rated at 20 amperes, F102 at 15 amperes, F103 at 5 amperes and F104 at 1/4 ampere.

SPECIAL REQUIREMENTS

Restarting After Overvoltage or Low-Line Conditions

If loss of line, excessively low-line, or overvoltage conditions on the +24V or +6V outputs occur, a crowbar mechanism is energized which shorts these two outputs. To restart, input power must be temporarily removed to allow the crowbar mechanism to reset.

Requirement for Fast Turn-On

If the input ac voltage is brought up slowly, the crowbar mechanism will be activated before the +6V and -6V outputs are turned on. The crowbar mechanism then prevents them from turning on. To reset the crowbar mechanism refer to the preceding paragraph.

Overcurrent Protection

The series regulators for the ±6V and +24V outputs contain electronic current-regulating circuitry which limits current to approximately 125% of rated load current. Fuses F101, F102, and F103 provide additional overcurrent protection in case the current limiting circuitry fails.

Temperature Compensation

The +24V output is compensated for temperature changes by a thermistor which must be connected across terminals R_T of TB112 or TB113. The 24V load can be connected on either the side or the rear of the power supply. To insure proper compensation, the thermistor should be connected at the same location as this load connection. The compensation coefficient of the thermistor is approximately -0.5% per degree C.

POWER SUPPLY ADJUSTMENT

All power supply adjustments are preset at the factory and normally need no adjustment. However, if adjustments are necessary, proceed as shown in the following sections. The potentiometers corresponding to each adjustment are:

Potentiometer	Adjustment
R216	+6V Output Voltage Adjustment
R242	-6V Output Voltage Adjustment
R249	Line Voltage Sense Adjustment
R338	24V Output Voltage Adjustment
R314	24V Crowbar Delay Adjustment

+24V Output Voltage Adjustment

The +24V output is adjusted using potentiometer R338. Turning R338 clockwise increases the output voltage.

+6V Output Voltage Adjustment

The +6V output is adjusted using potentiometer R216. Turning R216 clockwise increases the output voltage.

-6V Output Voltage Adjustment

The -6V output is adjusted using potentiometer R242. Turning R242 clockwise increases the magnitude of the output voltage.

Line Voltage Sense Adjustment

Transformer T102 senses the line voltage level for use by the control circuit. Adjustment of this sensing circuit is made as follows.

a. Turn R249 fully counterclockwise.

b. Make transformer tap connections to terminal block TB101 for 115 Vrms operation.

c. Apply 115 Vrms input line voltage.

d. Reduce line voltage to 94 Vrms.

e. Turn R249 clockwise until the +24V output turns off.

f. Before the power supply will operate again, input power must be momentarily removed.

24V Crowbar Delay Adjustment

R314 provides adjustment of the time period between sensing loss of input power and crowbarring the 24V output. This adjustment, if preset at the factory, normally needs no adjustment. However, if adjustment is necessary, proceed as follows:

a. Apply input ac power.

b. Monitoring the +24V output with a scope which is synchronized with the fault signal, turn the power supply off and measure the time delay before the 24V output drops.

c. Adjust R314 and repeat step b. until the desired delay (1 ms max.) is obtained.

DESCRIPTION

As in any control system, 3C power supplies are merely a combination of simpler circuits, any one of which is easily understood. This section describes and relates these simpler circuits to provide a complete understanding of the MP-40 and MP-40E power supplies. Component reference numbers shown in diagrams in this section are the same reference numbers shown in circuit diagrams listed previously in this manual.

DEVICE DESCRIPTION

The following is a description of the less familiar devices used in this power supply.

Zener Diodes

A normal diode voltage-current characteristic looks like that shown in Figure 1-24.

For silicon diodes, particularly of the diffused junction types, there is an abrupt breakdown in the reverse direction as shown by the dotted line in the figure. As can be seen from the sketch, any current in excess of I_{R1} drawn through the device in the reverse direction will result in a constant voltage appearing across the device. Silicon diodes designed to utilize this feature are called "zener" types. This constant voltage is used as a voltage reference source in all 3C power supplies. The symbol for a zener diode is shown in Figure 1-25. In a circuit application, the zener diode is connected in series with a current-determining resistor across some dc voltage as in Figure 1-26.

Silicon-Controlled Rectifiers

A silicon-controlled rectifier (SCR) is a device that blocks current flow in both directions until a pulse is put into what is called the "gate." At this time, the device will conduct in one direction; it will block current in both directions only after the current has been reduced to zero. The symbol for a SCR is shown in Figure 1-27; "G" designates the gate lead.

MP-40 POWER SUPPLY

Figure 1-28 is a block diagram of the MP-40 power supply. Input ac is delivered to the input power converter which contains a constant voltage transformer (CVT). Secondaries of this CVT are rectified and filtered to provide pre-regulated bulk dc power for two series regulators, a shunt regulator and related control circuitry. The two series regulators further regulate the voltage from the CVT to provide the +24V and the +6V outputs. Additional regulation for the -6V output is provided by a shunt regulator. A temperature-compensated reference voltage is provided for the +24V series regulator.

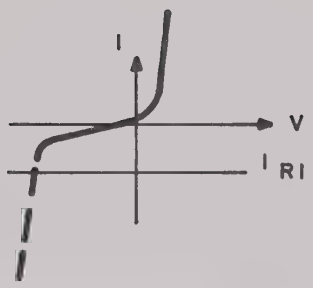


Figure 1-24. Diode Voltage-Current Characteristic

Figure 1-25. Zener Diode Symbol

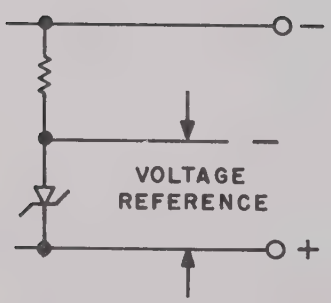


Figure 1-26. Zener Diode Circuit Connection

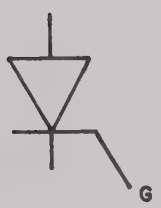


Figure 1-27. Silicon-Controlled Rectifier Symbol (G = Gate)

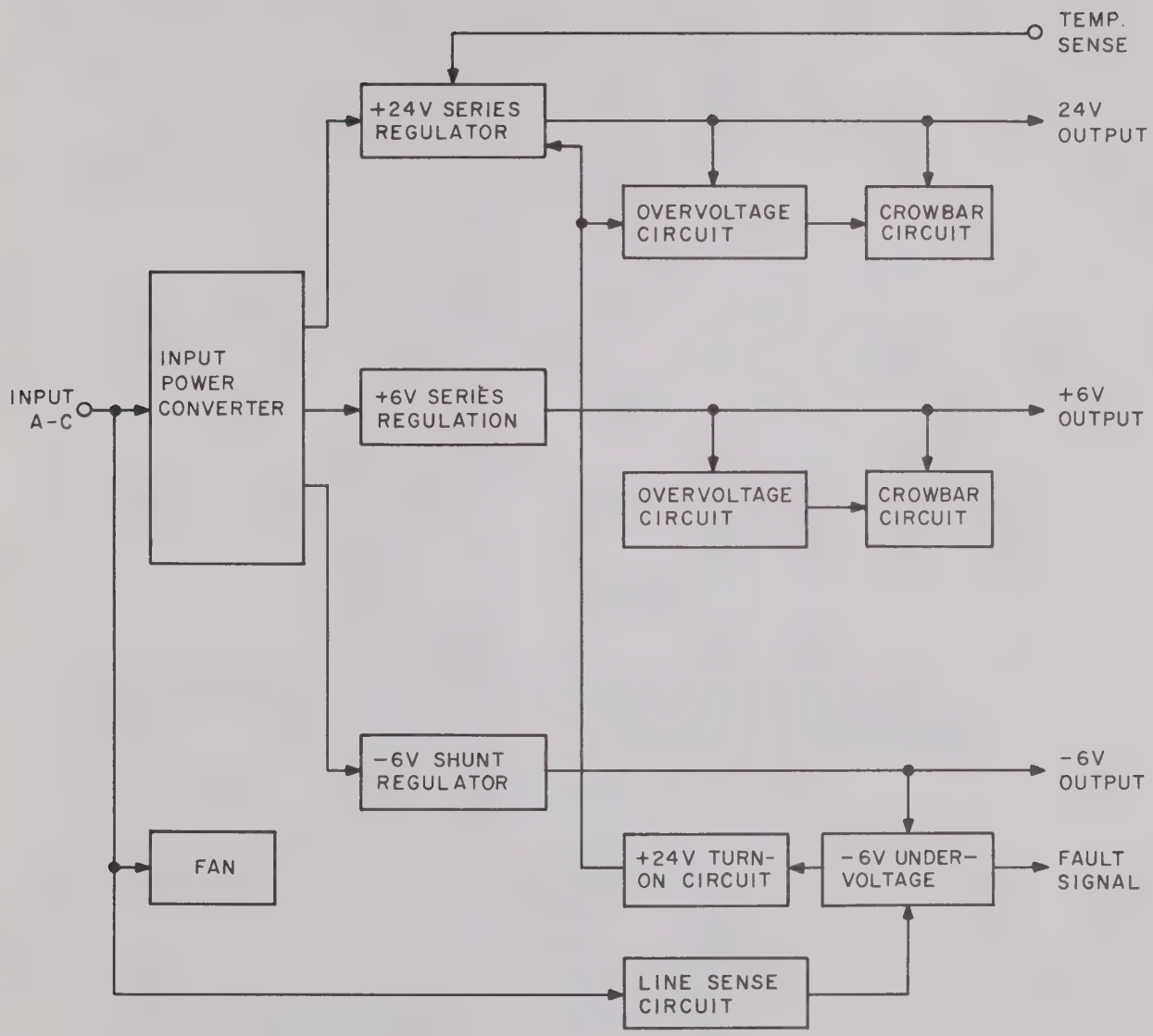


Figure 1-28. Block Diagram - PR36 - MP-40/MP-40E Power Supply

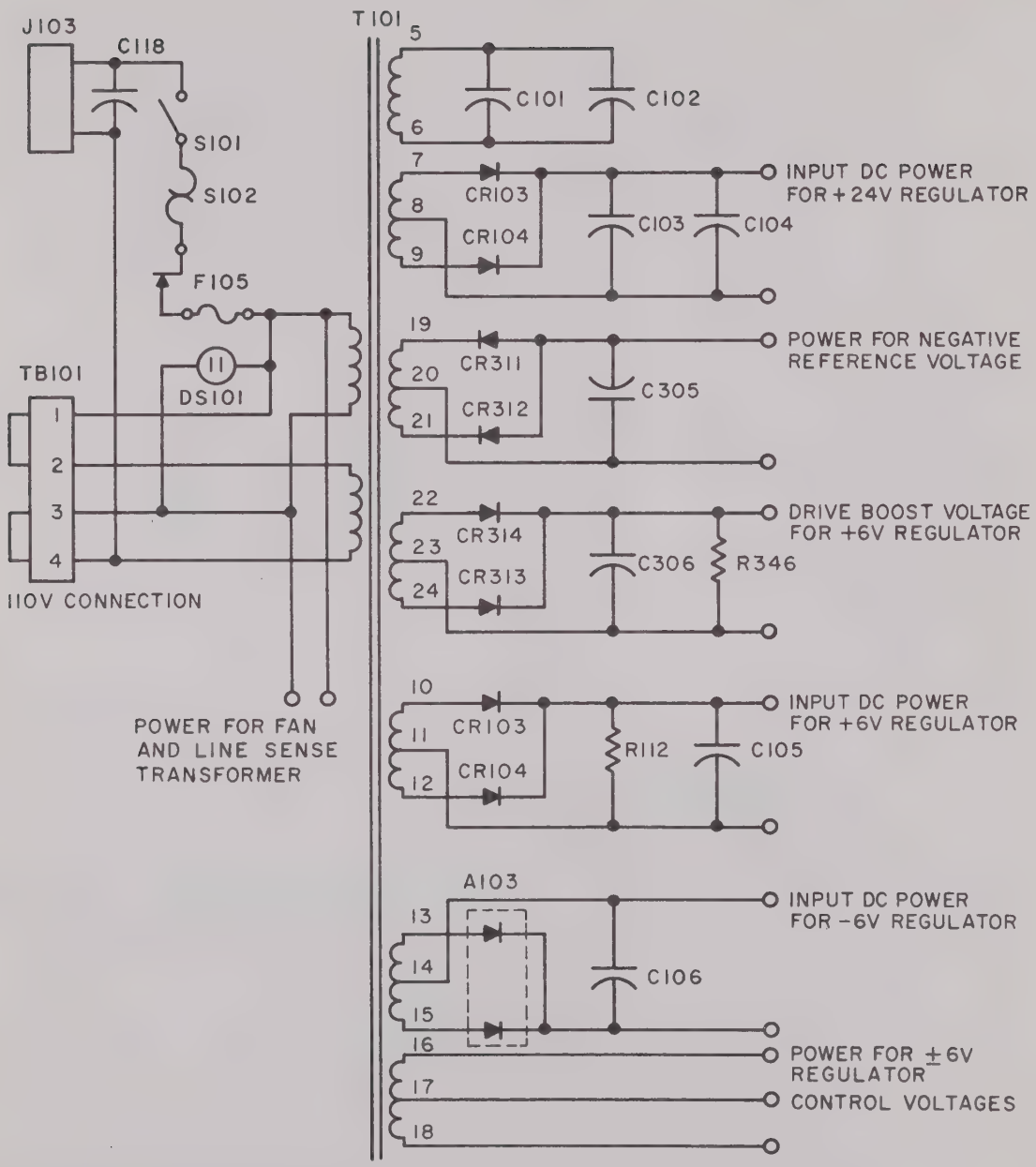


Figure 1-29. Constant Voltage Transformer, Schematic Diagram

The sequencing and power control circuitry is enclosed by dotted lines in the block diagram. The crowbar circuits clamp the +6V and +24V outputs when a signal is received from the overvoltage circuits. The logic circuit provides control for the +24V turn-on relay when signals are received from the -6V undervoltage circuit or the line sense circuit. A +4 to +6 volt fault signal is provided during normal operation.

When the power supply is turned on, the ±6 volt outputs and the fault signal appear before the 24V output. The charge rate of the output filter capacitors delays the rise of the ±6V outputs until the line voltage is high enough to prevent the line sense circuit from firing the silicon controlled rectifier which grounds the ±6V outputs when a low line condition occurs. When the ±6V outputs have exceeded 90% of nominal, the 24V turn-on circuit is energized, which controls the 24V output.

Overvoltage conditions on the +6V and +24V outputs are sensed by the respective overvoltage circuit, which provides a trigger signal to its crowbar circuit. This quickly drops the affected output to a very low voltage. During turn-off or loss of ac power, the 24V output is held on for a minimum of 1 millisecond and an RC network. The +24V turn-on circuit then activates the +24V overvoltage and crowbar circuits, which quickly drops the 24V output to a low voltage. The ±6V outputs remain in the regulation band until the +24V output has decreased to less than 20% of nominal.

Input Power Converter

The input power converter is shown in Figure 1-29. Constant voltage transformer T101 uses the resonant circuit consisting of C101, C102 and the leakage inductance of T101 to provide a regulated ac voltage on each of its secondary windings (Figure 1-30 shows the waveform which appears on each secondary). These secondaries are rectified and filtered to provide the required dc input power to the +24V, +6V, and -6V regulators and related control circuitry.

The primary is split to allow operation from either 110 Vac or 220 Vac. One of the primaries provides 110 Vac power to the fan and to the power on light DS101.

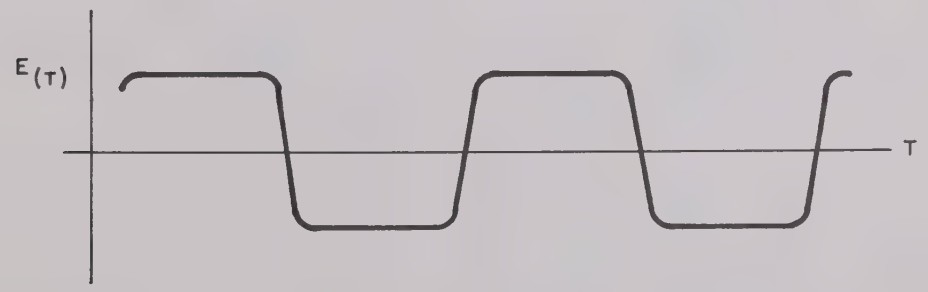


Figure 1-30. Secondary Winding Voltage Waveform

+24V Series Regulator Circuit

The +24V series regulator provides further regulation of a dc voltage from constant voltage transformer T101. Figure 1-31 is a block diagram of a typical series regulator. The +24V series regulator is shown in Figure 1-32 with the blocks of Figure 1-31 indicated by dashed lines.

When the 24V turn-on circuit is activated a positive dc voltage is supplied to zener diode CR305. Q307 provides a constant current drive source which is determined by zener diode CR305, resistor R323, and the emitter-base forward voltage drop of Q310. This current is supplied to the base of Q309. The emitter current of Q309 provides base drive current for Q107, which in turn provides base drive current for power transistors Q101 through Q106. These transistors are connected in parallel to provide the required load current. Resistors R101 through R106 compensate for differences in the gain of transistors Q101 through Q106 such that they share the load current equally. The load current is filtered by C113. Transient protection is provided for the 24V output by C114, C115, C116, and C117.

Regulation is provided by controlling the base current of Q308. Whenever Q308 conducts, it shunts drive current (supplied by Q307) away from the base of Q309, which in turn reduces drive current to Q107 and therefore reduces +24V load current. The +24V output can thus be regulated by controlling Q308. The base current of Q308 is determined by Q310 base current. Q310 base current will be the difference between R331 current and the current shunted away through CR306 and CR307. CR306 current will be the difference between R333 current and R336 current. Since R336 current is fixed by the reference voltage level, this difference current is controlled through R333 by output voltage. The net result is that R333 current varies Q308 emitter current as required to hold the +24V output voltage constant.

Transistors Q310 and Q308 are stabilized by R330, C304, R328 and C303. These components prevent oscillation of the +24V output. Diodes CR306 and CR307 are used to compensate for changes in emitter-base voltage drops across Q310 and Q308 as temperature varies. Resistor R338 provides voltage adjustment for the +24V output. CR110 prevents damage to the regulator in the event that a reverse voltage is applied to the +24V output terminals.

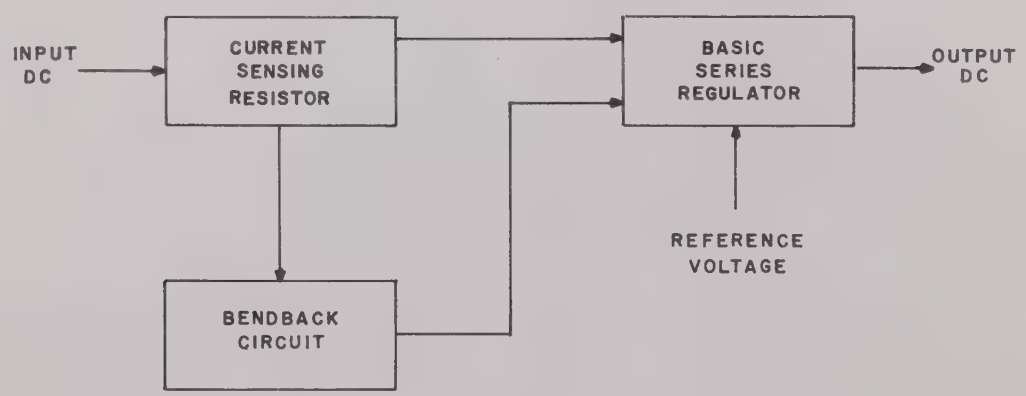


Figure 1-31. Series Regulator, Block Diagram

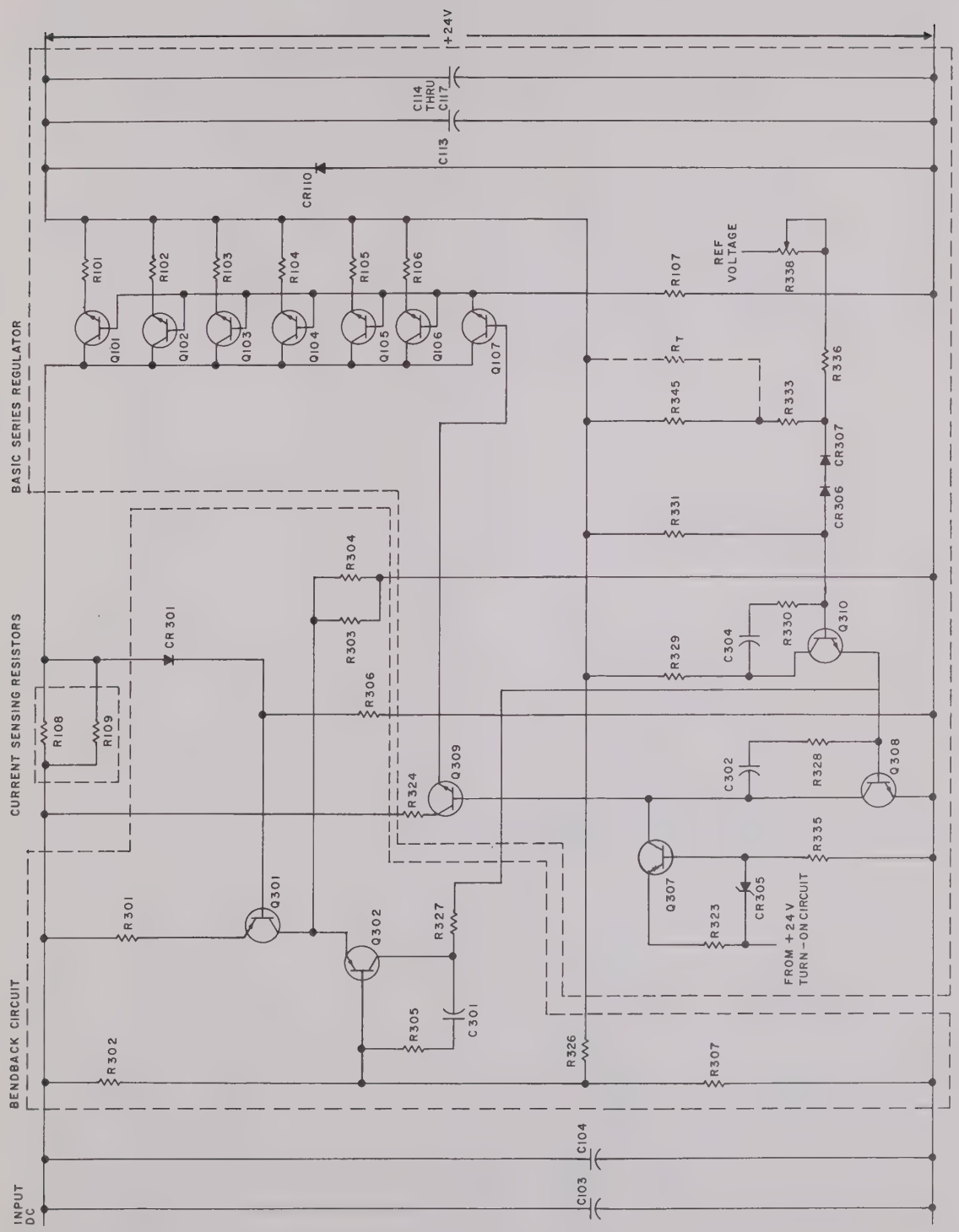


Figure 1-32. +24V Series Regulator, Schematic Diagram

If the +24V output is overloaded, the bendback circuit operates. The +24V output has a bendback characteristic as shown in Figure 1-33. The small voltage across current-sensing resistors R108 and R109 also appears across R301, so that Q301 emitter current (and therefore Q301 collector current) is proportional to load current. Q301 collector current flows through R303 and R304. Transistor Q302 compares the voltage across R303 and R304 to the voltage across R307. (The voltage across R307 is derived from input dc and output dc through R302 and R326, respectively.) When the maximum load is exceeded, Q302 emitter voltage exceeds Q302 base voltage and the transistor conducts. This provides current through R327, which increases the base drive current of Q308. The amount of current shunted away from the base of Q309 is increased and therefore output current is reduced, providing the desired bendback characteristic. C301 and R305 stabilize Q302, preventing oscillation of the bendback circuit. R303 is selected to determine the current level at which bendback occurs.

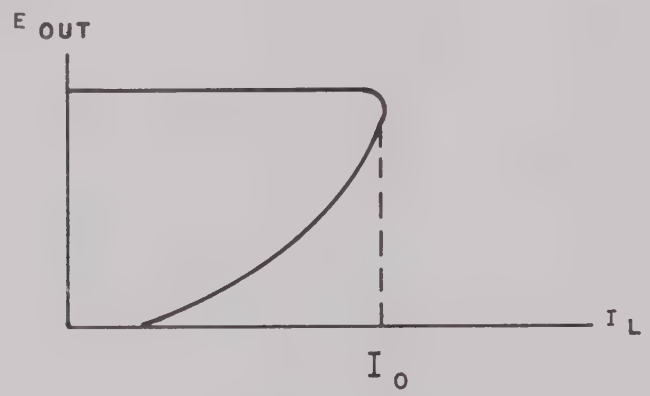


Figure 1-33. Output Voltage-Current Characteristic of the Series Regulator

The +24V output is temperature compensated by an external thermistor connected across terminals R_T of TB112 or TB113. (A thermistor is a resistor whose resistance varies inversely with temperature.) The thermistor is connected in parallel with R345. The temperature changes at the thermistor location will vary the current through R333 and will therefore vary the output voltage accordingly.

+6V Series Regulator Circuit

The +6V series regulator is similar to the +24V series regulator. This regulator is shown in Figure 1-34.

Transistor Q204 receives base drive current from the constant current drive source consisting of CR204, Q203, and R210. The emitter current of Q203 provides base drive for Q111, which in turn supplies base drive current for power transistors Q108, Q109, and Q110. Resistors R117, R118, and R119 compensate for differences in the gain of these transistors such that they share the load current equally. C108 filters the +6V output voltage. Transient protection for the +6V output is provided by C111 and C112.

Regulation is provided by controlling Q205 current. Whenever Q205 conducts, it shunts drive current away from the base of Q204, which in turn reduces drive current to Q111 and therefore reduces +6V load current. The +6V output can thus be regulated by controlling Q205. The base current of Q205 is determined by Q206 base current, which is determined by the difference between R215 current and the current shunted away through CR205 and CR206. This current will be the difference between R217 current and R218 current. Since R218 current is fixed by the reference voltage level, this difference current is controlled through R217 by output voltage. The net result is that this difference current varies Q205 emitter current as required to hold the +6V output voltage constant.

Transistor Q205 is stabilized by C202 and R213. These components prevent oscillation of the +6V output. Diodes CR205 and CR206 are used to compensate for changes in the emitter-base voltage drops of Q205 and Q206 as temperature varies. R216 provides voltage adjustment for the +6V output. CR109 protects the series regulator from damage in the event that a reverse voltage is applied to the +6V output terminals.

The +6V bendback circuit will operate when the +6V output is overloaded. The bendback characteristic of the +6V output is similar to that of the +24V output as shown in Figure 1-33. The small voltage across current sensing resistor R110 appears across R201 so that Q201 emitter current (and therefore Q201 collector current) is proportional to load current. Q201 collector current flows through R204 and R205. Transistor Q202 compares the voltage across R204 and R205 to the voltage across R206. (The voltage across R206 is derived from input dc and output dc by R202 and R207, respectively.) When the maximum load is exceeded, Q202 starts to conduct, providing current through R209 which increases the base drive current of Q205. The amount of current shunted away from the base of Q204 is increased and therefore the load current is reduced, providing the desired bendback characteristic. C201 and R208 stabilize Q202, preventing oscillation of the bendback circuit. R204 is selected to determine the current level at which bendback occurs.

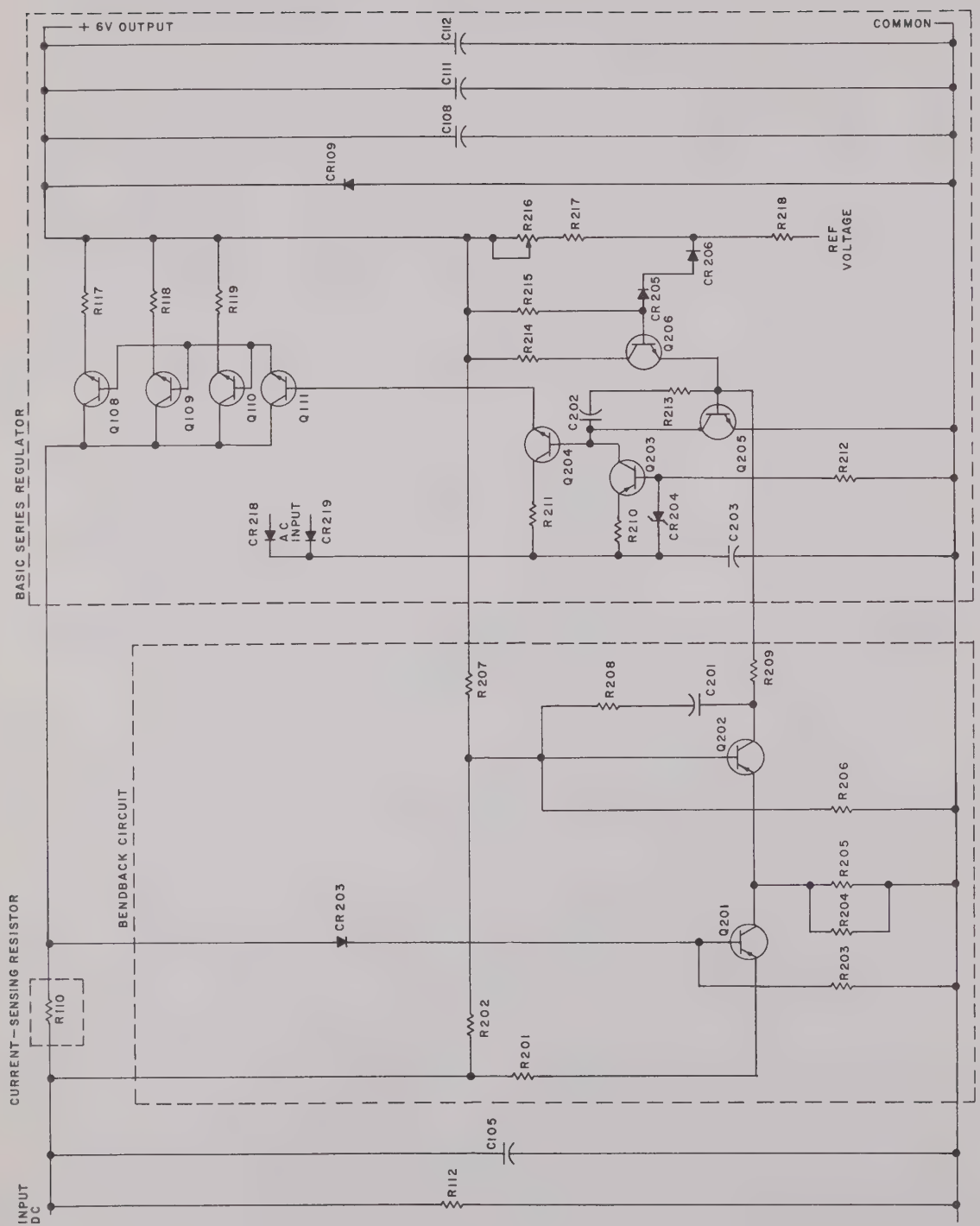


Figure 1-34. +6V Series Regulator, Schematic Diagram

-6V Shunt Regulator Circuit

Regulation of the -6V output is provided by the shunt regulator shown in Figure 1-35. One secondary of the constant voltage transformer system provides a dc voltage across C106, providing input power to the shunt regulator. Load current and the current shunted through transistor Q113 flows through resistors R111 and R124. The voltage drop across these resistors accounts for the difference between the input dc voltage across C106 and the -6V output voltage across C107. As the load current varies, the shunt regulator controls the current through Q113 such that the voltage drop across R111 and R124 will be that necessary to maintain the output at -6 volts.

Drive current for Q113 is provided by Q112. Drive current for Q112 is provided by Q215. The shunt regulator control circuit (shown in dotted lines in Figure 1-35) controls Q215 current such that Q113 conducts as required to hold the output at -6 volts.

The output voltage of the +6V series regulator is used for -6V reference voltage. (A decoupling circuit consisting of CR207 and C204 is used to prevent +6V output transients from affecting regulation of the -6V output.) This voltage generates a constant current through R218, which provides a maximum base drive for Q213. The current through R241 shunts part of this drive current away from Q213. Q213 collector current controls Q214 base current. Q214 collector current controls Q215, which in turn controls Q112 and Q113. The net result is that R241 current varies as required to hold the -6V output at a constant voltage.

+6V Overvoltage and Crowbar Circuit

The +6V overvoltage and crowbar circuit is shown in Figure 1-36 . When an overvoltage condition is detected on the +6V output, the crowbar circuit is triggered, reducing the +6V output to a low voltage. Q211 is normally held off by R236 current, which is derived from a negative reference voltage. When the +6V output rises above the maximum allowable voltage, the current through R238 exceeds R236 current, and Q211 turns on. Q211 collector current then supplies base drive for Q212, and Q212 turns on. Q212 then provides a gate signal for silicon controlled rectifier CR108. CR108 then turns on and shorts out the +6V output through R114. This quickly drops the +6V output to a very low voltage.

+24V Overvoltage and Crowbar Circuit

The +24V overvoltage and crowbar circuit is shown in Figure 1-37. When an overvoltage condition occurs on the +24V output, the overvoltage circuit provides a gate trigger signal to the +24V crowbar circuit, which drops the +24V output to a low voltage. During normal operation, R337 current, which is derived from a negative reference voltage, flows through CR309 and holds Q314 off. When the +24V output rises above the maximum allowable voltage, the current through R339 exceeds R337 current, which turns Q314 on. Q314 collector current then turns Q313 on, which in turn provides a gate signal for silicon-controlled rectifier CR111. CR111 then turns on, and the +24V output is quickly dropped to a very low voltage. System power must be temporarily interrupted to restore

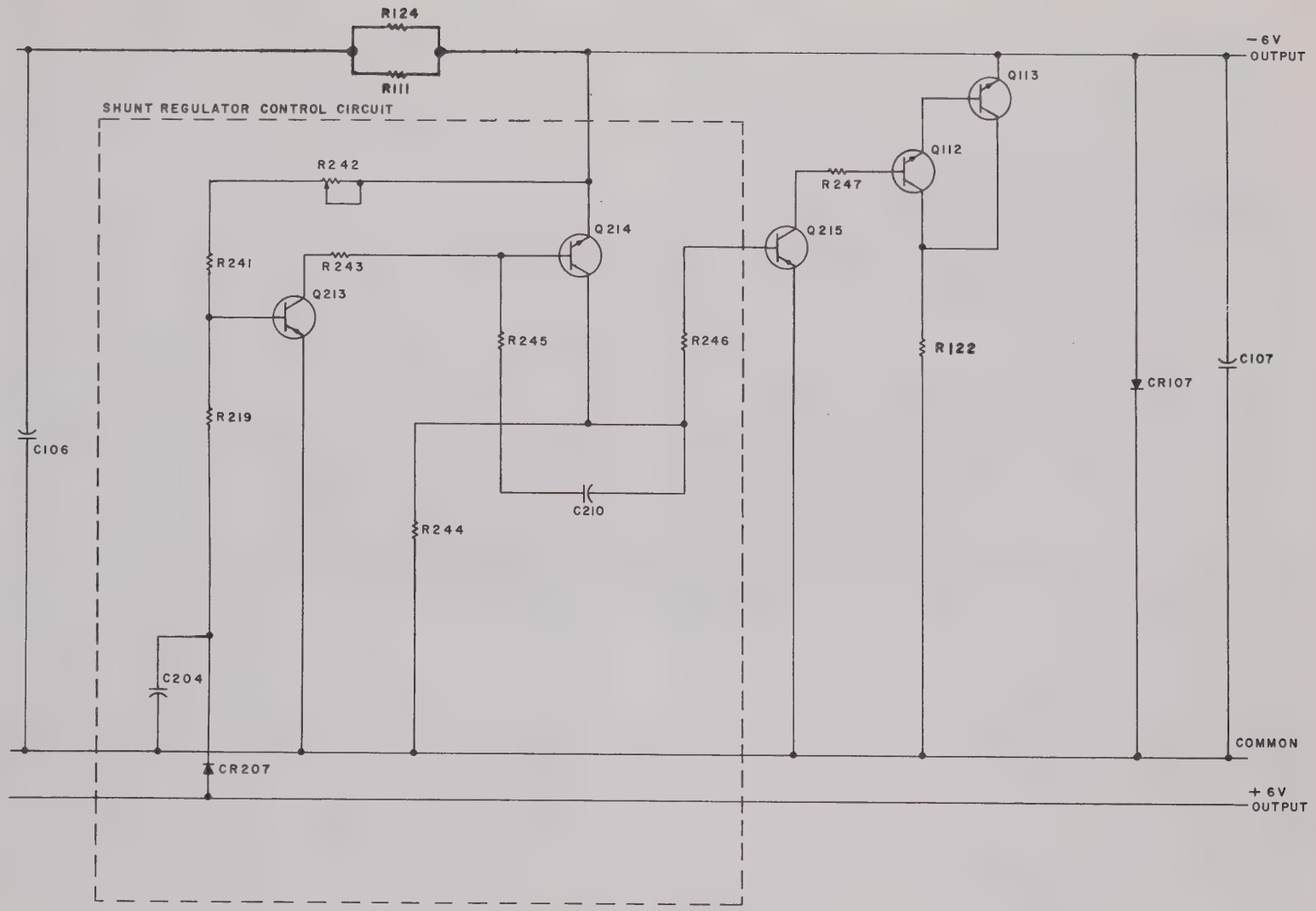


Figure 1-35. -6V Shunt Regulator, Schematic Diagram

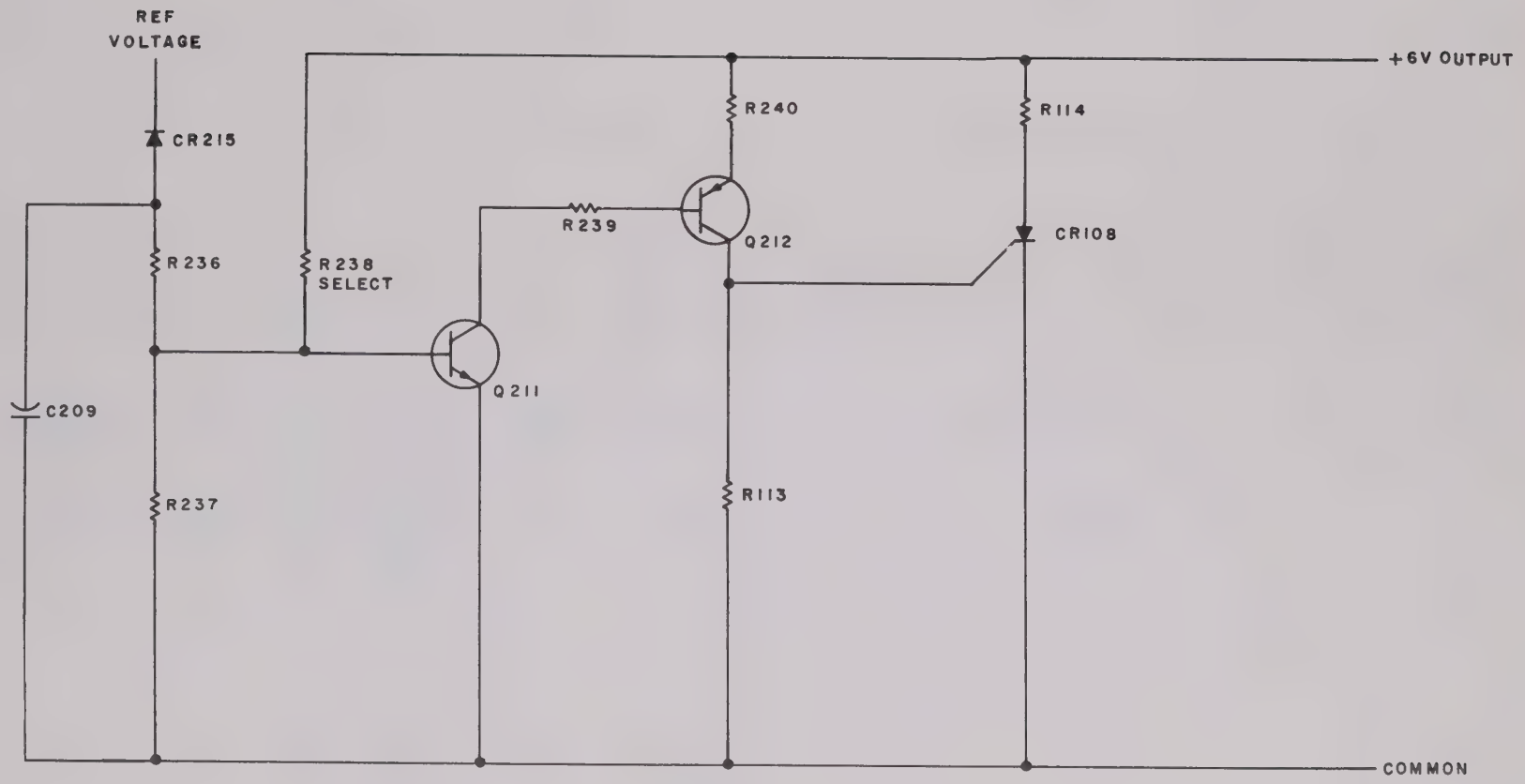


Figure 1-36. +6V Overvoltage and Crowbar Circuits, Schematic Diagram

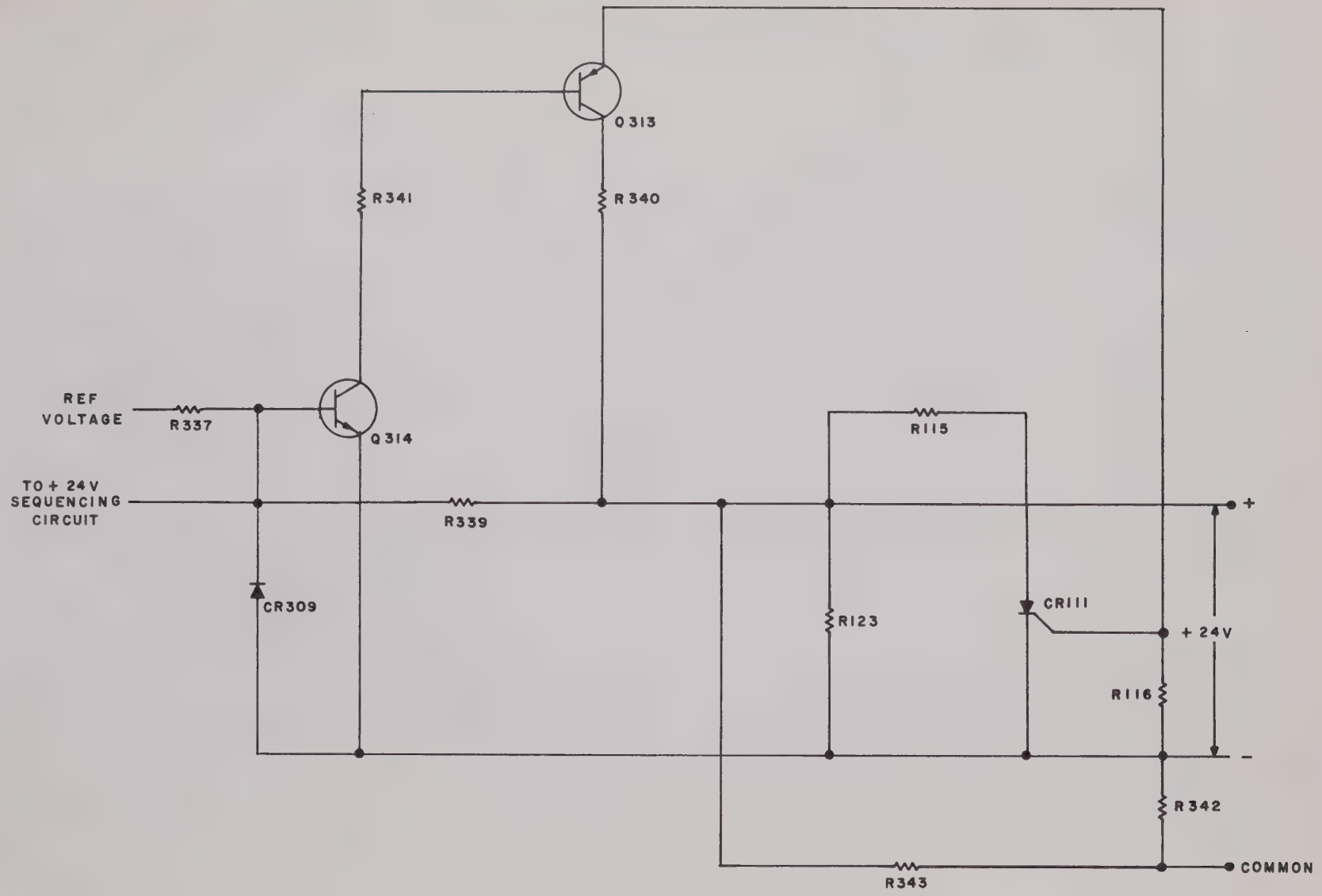


Figure 1-37. +24V Overvoltage and Crowbar Circuits, Schematic Diagram

the +24V output. Resistors R342 and R343 are used to derive the +12V output (with respect to the ±6V common) from the +24V output terminals. Resistor R123 is included to keep the +24V output at light load if the load is removed.

+24V Turn-On Circuit

The +24V turn-on circuit is shown in Figure 1-37. During turn-on, transistor Q303 is turned off by the -6V undervoltage circuit (Figure 1-41) after the ±6V outputs have exceeded 90% of nominal. This allows current through R310 (determined by the zener voltage of zener diode R302) to turn Q302 on which turns Q305 and Q306 on. When the contacts of Q306 are closed, a dc voltage is supplied to the constant current drive source of the +24V series regulator, allowing the +24V series regulator to turn on. This voltage is comprised of the input voltage to the +24V series regulator and an additional dc boost voltage (across C306) derived from a separate winding of constant voltage transformer T101 through rectifiers CR313 and CR314. The additional boost voltage is provided to insure that adequate drive is available for the +24V series regulator.

During turn-off or a loss of line condition, the +24V output must remain in regulation for at least 1 millisecond, and the +24V output must be dropped to 20% of nominal before either the -6V or +6V output drops out of regulation. The 1 millisecond delay in turning off is provided by an RC network consisting of R314 and C302. The line sense and fault signal circuit (Figure 1-42), via Q210 of the -6V undervoltage circuit (Figure 1-41), turns Q303 off when loss of line is sensed. After the one millisecond delay period, Q304 turns off, which turns Q305 and Q306 off. When Q306 turns off, drive current for Q311 is removed, Q311 turns off, and current flows through R332 for the +24V overvoltage circuit (Figure 1-37), which in turn crowbars the +24V output. Crowbarring this output insures that it will be below 20% of nominal before the ±6V outputs drop out of regulation.

Reference Source Circuit for +6V Output

The reference source circuit for the +6V output is shown in Figure 1-39. This circuit supplies a negative reference voltage across zener diode CR208 for the +6V series regulator.

An ac input voltage is supplied from constant voltage transformer T101 and is rectified by diodes CR216 and CR217. Capacitor C205 is used to filter this voltage. A constant base drive current is provided for Q207 by zener diode CR209 and R221. The Q207 collector current therefore provides a low ripple dc current source for zener diode CR208, which in turn provides a stable reference voltage for the +6V series regulator and the +6V overvoltage circuit.

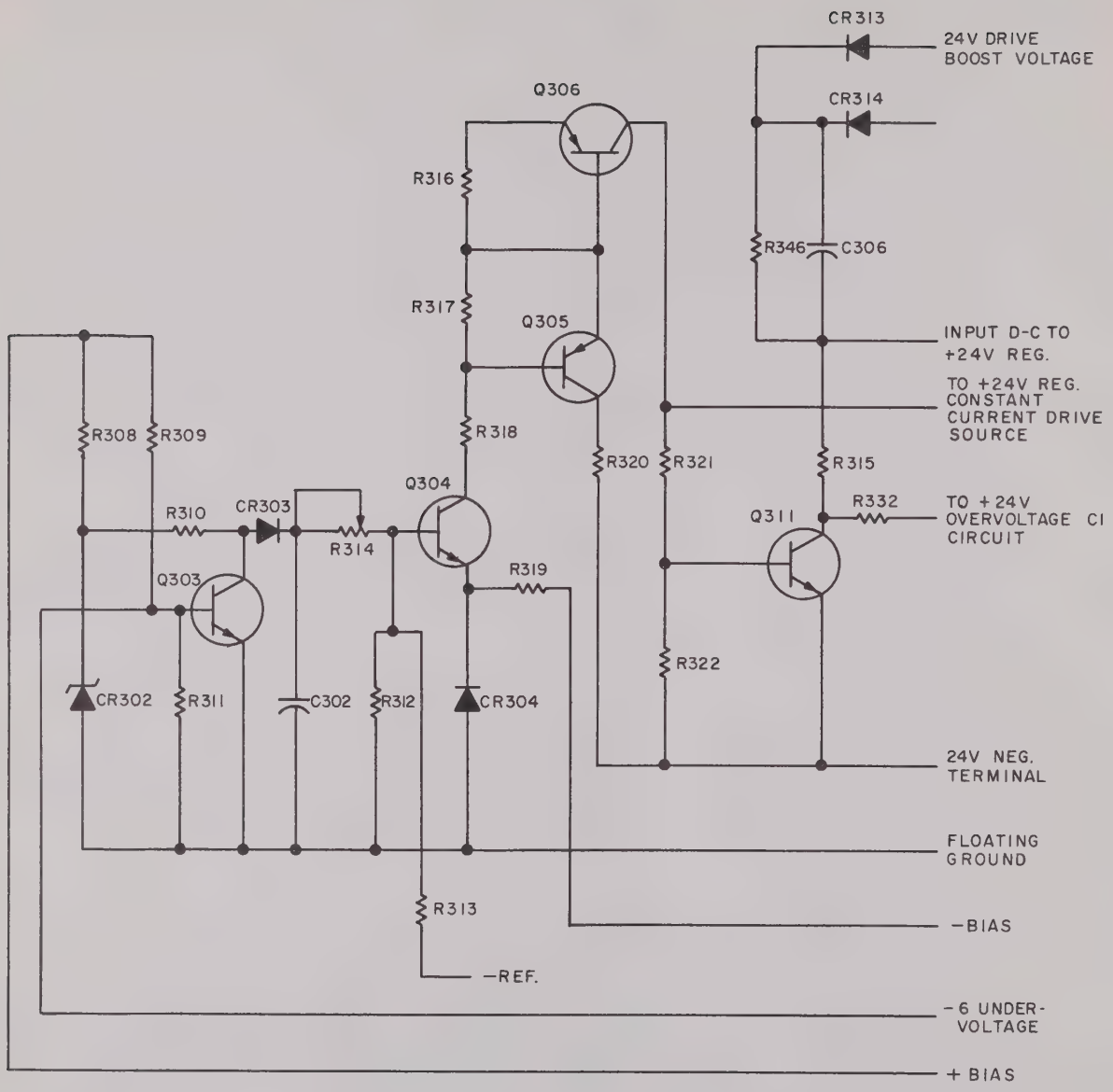


Figure 1-38. +24V Sequencing Circuit, Schematic Diagram

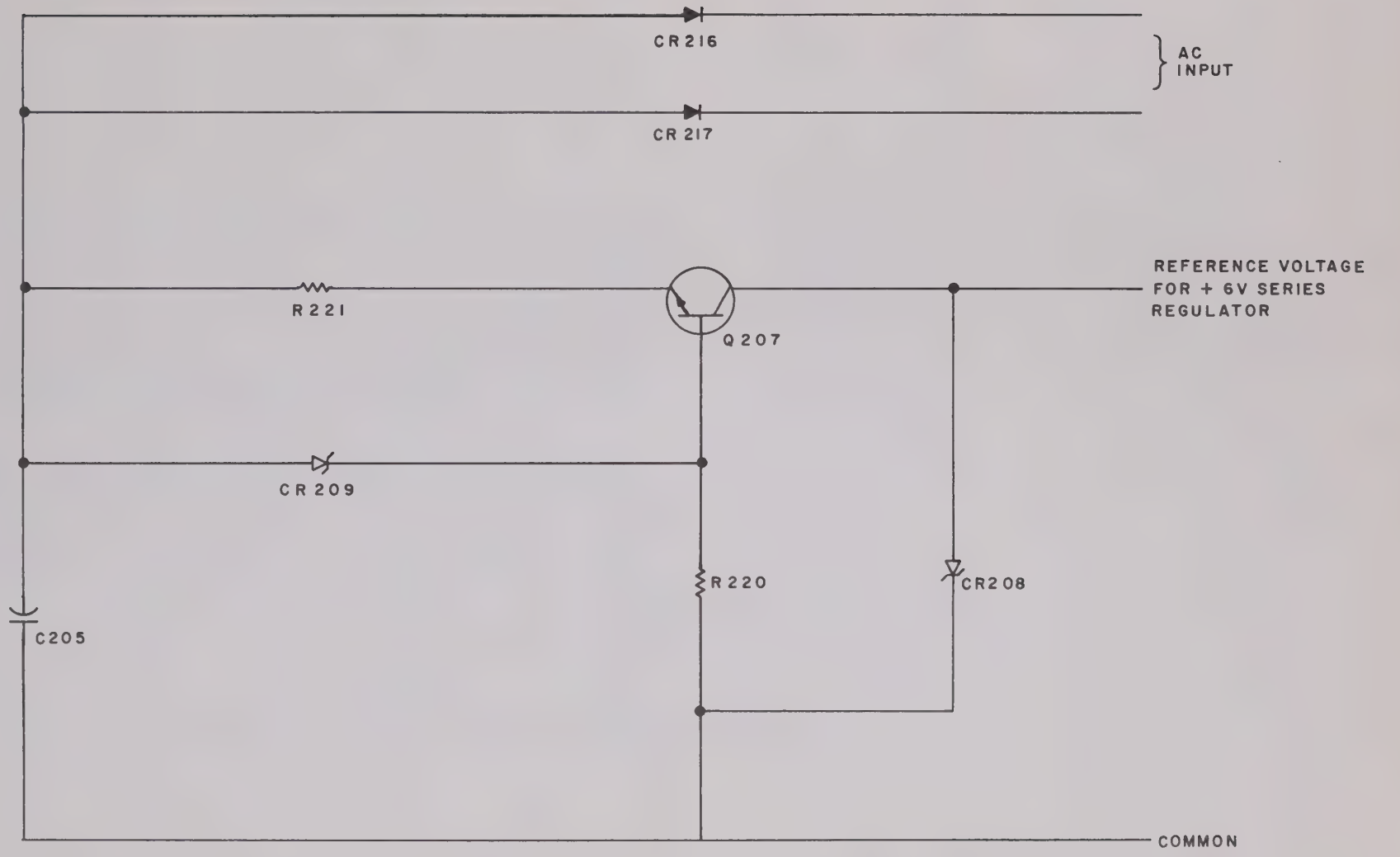


Figure 1-39. +6V Output Reference Voltage Circuit, Schematic Diagram

Reference Source Circuit for +24V Output

The reference source circuit for the +24V output (shown in Figure 1-40) provides a positive reference voltage across zener diode CR210 for the +24V series regulator.

An ac input voltage is supplied by constant voltage transformer T101 and is rectified by diodes CR311 and CR312. C305 is used to filter this voltage. A constant base drive current is provided for Q312 by zener diode CR308 and resistor R334. The collector current of Q312 supplies a low ripple dc current source for zener diode CR310, which provides a constant reference voltage for the +24V series regulator and the +24V overvoltage circuit.

-6V Undervoltage Circuit

The -6V undervoltage circuit is shown in Figure 1-41. During turn-on of the power supply, this circuit prevents the +24V output from energizing until both the +6V and -6V outputs have exceeded 90% of their nominal voltages.

A reference voltage determined by zener diode CR210 provides a constant current through R230 which holds Q209 on whenever this current exceeds R231 current. When the -6V output rises above 90% of nominal, the current through R231 exceeds the current through R230, and Q209 turns off. This allows R234 current to turn Q210 on, which allows the +24V turn-on circuit to turn on the +24V output.

Line Sense and Fault Signal Circuit

The line sense and fault signal circuit is shown in Figure 1-42. A +4 to +6 volt fault signal is derived from the +6V output by R228 and CR213 whenever input ac voltage is above the minimum allowable line voltage. The line-sensing circuit removes the fault signal and turns the +24V output off whenever a low line condition occurs.

Input ac voltage appears across line sensing transformer T102. The secondary voltage of T102 is rectified by CR201 and CR202 to provide a dc voltage for use by the line sense circuit. A reference voltage across zener diode CR210 is derived from the input voltage to the +6V regulator by R224 and CR210. When input ac voltage drops below a predetermined level (low line), Q208 base voltage drops below this reference voltage, which turns Q208 on. Q208 then delivers a current through R226 and CR211 to the gate of silicon-controlled rectifier CR212. Firing this SCR grounds the fault signal. Grounding the fault signal also removes base drive to Q210 of the -6V undervoltage circuit, which turns off the +24V output via the +24V turn-on circuit. R249 permits adjustment of the low line sensing point. Zener diode CR220 is included to make the voltage across CR206 more sensitive to line variations and therefore minimize the time required to sense a low line condition. R229 determines the impedance from the fault signal terminal to ground after the fault signal is removed. Additional circuitry is included to turn off the power supply when a high line voltage transient occurs. This transient will be reflected on the secondary of T102. If this secondary voltage exceeds the sum of the breakdown voltages of zener diodes CR220 and CR222, CR222 will conduct. This fires SCR CR221, which clamps Q208 on. This grounds the fault signal and turns off the +24V regulator (via the +24V turn-on circuit). This condition will remain until input ac power has been removed and then reapplied.

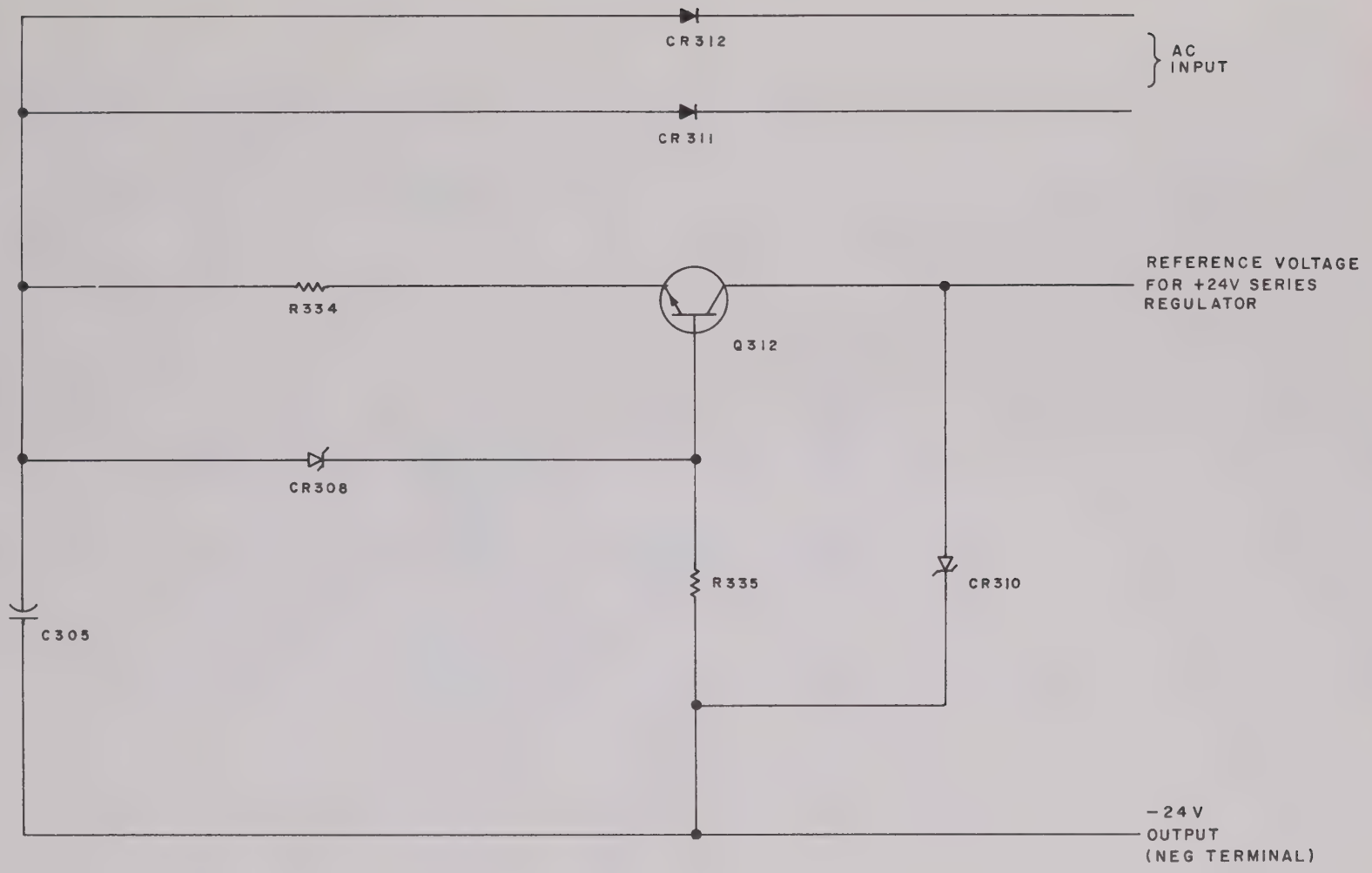


Figure 1-40. +24V Output Reference Voltage Circuit, Schematic Diagram

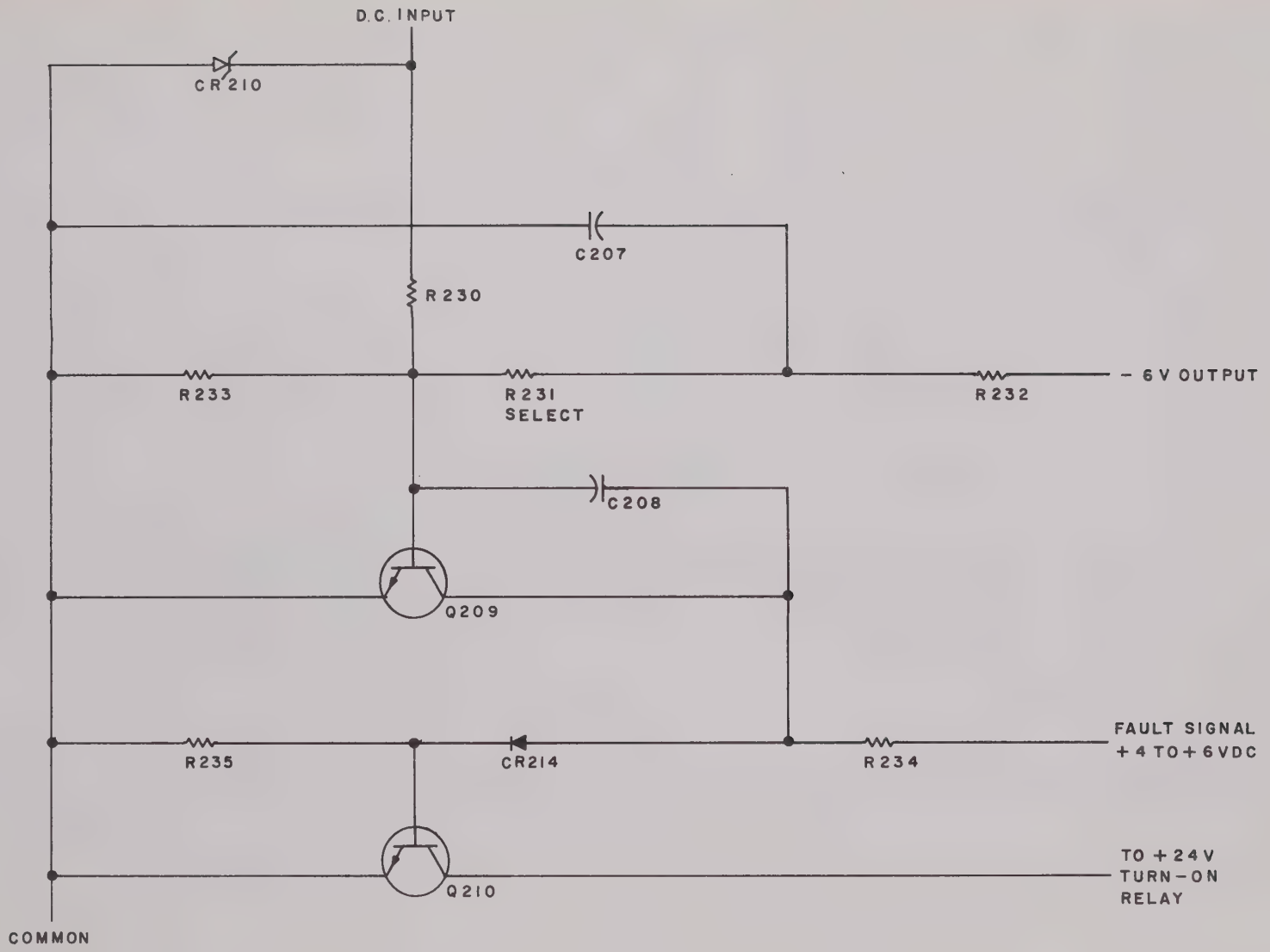


Figure 1-41. -6V Undervoltage Circuit, Schematic Diagram

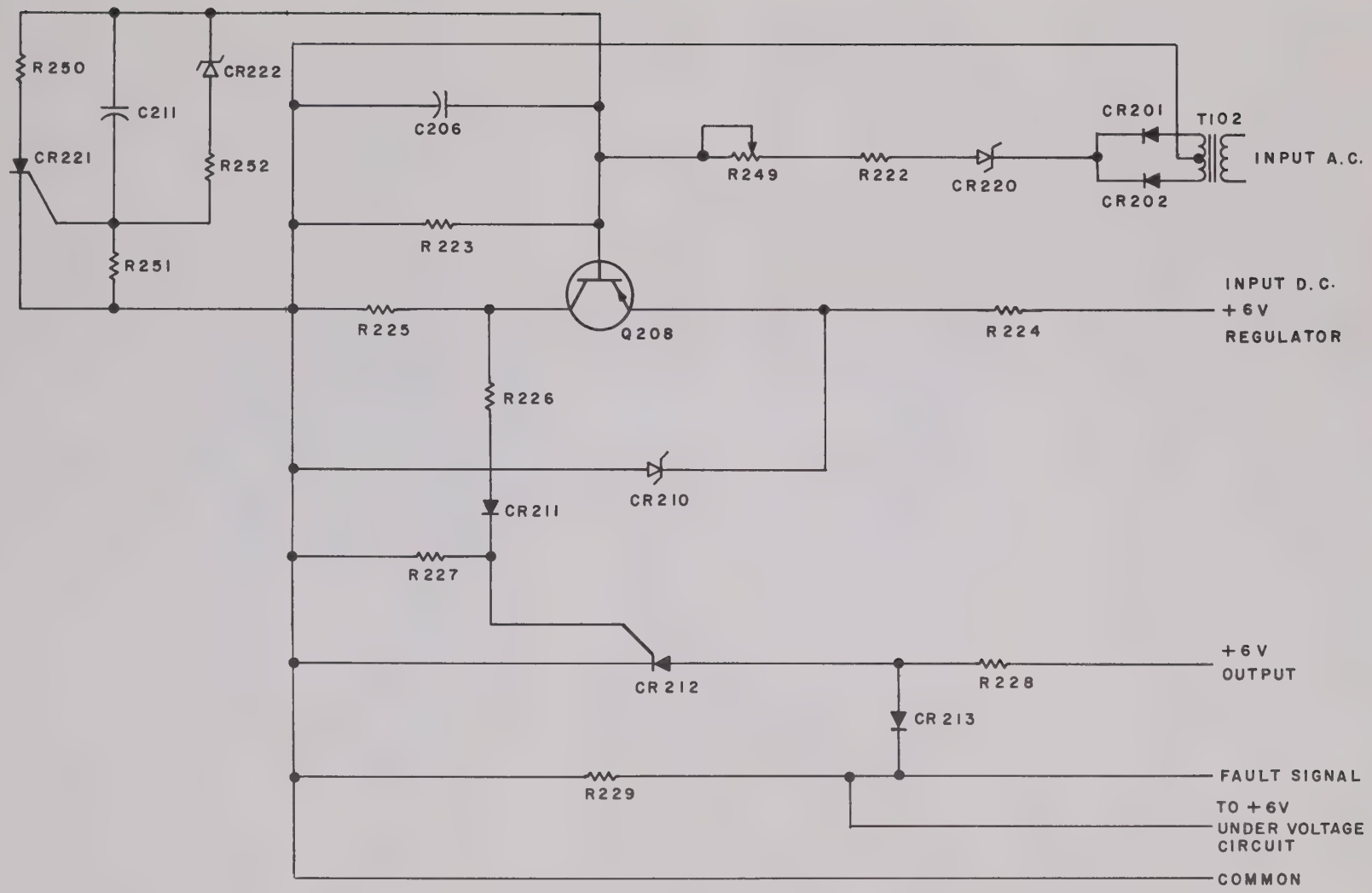


Figure 1-42. Line Sensing and Fault Signal Circuit, Schematic Diagram

MAINTENANCE

The MP-40 power supply has been designed to give trouble-free operation without routine maintenance. If any problems should occur, however, the following information will be helpful.

REPLACEMENT PARTS

Replacement parts can be purchased directly from Ault Incorporated. Most of the components are standard electronic parts and generally can be obtained more quickly locally. Several components, such as transformers and chokes, are manufactured by, or especially for, Ault Incorporated, and replacement parts should be ordered from the factory.

Care should be taken that the transistors and diodes are not replaced unless they are actually causing circuit malfunction. Care should also be exercised when soldering to transistors or rectifiers to prevent destruction of junctions by excessive heat.

Fuse Replacement

See Installation and Adjustment section of this manual.

SAFETY PRECAUTIONS

WARNING

Before troubleshooting or testing of the MP-40 power supply, the following precautions should be taken.

The chassis must be connected to system ground. The chassis is grounded through a stud on the rear panel. It is important that the input ac line be connected to system ground.

Before troubleshooting the supply, refer to the troubleshooting chart. When measurements must be made in the power supply, test instrument cases should be grounded.

CAUTION

All test equipment connections should be made with input power removed.

TROUBLESHOOTING

Initial Troubleshooting Procedure

Check the supply, particularly for burned or damaged parts, foreign matter, and loose leads.

Check fuses F101, F102, F103, F104, and F105 for continuity. If faulty replace with a fuse of the same type. (See Installation and Adjustment section of this manual.)

Recommended Test Equipment

The following test equipment is recommended for troubleshooting the MP-40 power supply:

a. DC voltmeter, 75 volts full scale.

b. AC voltmeter, 300 volts rms full scale.

c. Ohmeter, 1, 100, and 10,000 ohm scales.

A circuit card puller (No. 685-1081) and a circuit card extender (No. 180-1960), are available directly from Ault Incorporated.

Circuit Board Malfunctions

When troubleshooting the MP-40 power supply, circuit card malfunctions should be corrected by replacement of the defective plug-in card. An improperly corrected circuit card can damage the power supply.

Apparent circuit card malfunctions (Table 1-2, symptom 5) may be due to improper adjustment of one of the potentiometers. Circuit card adjustments are described in Installation and Adjustment section of this manual.

Table 1-2.
Troubleshooting Chart

Symptom	Possible Causes
1. No +6V or +24V output voltage. No fault signal. Low -6V output voltage.	a. Shorted capacitor: C108, C111, or C112 b. Shorted Rectifier: CR103, CR104, CR108 or CR109. c. Blown fuse: F102. * d. Open Resistor: R110
2. No +6V, -6V or +24V output voltage. No fault signal.	a. Shorted capacitor: C101, C102, C103, C104 or C105. b. Blown fuse: F105. * c. Open thermostat: S102. ** d. External circuit breaker open. (See sympton No. 22.) **

* Installation and Adjustment section
** Maintenance section

Table 1-2. (Cont)
Troubleshooting Chart

	Symptom	Possible Causes
3.	No +24V or -6V output voltage.	a. Shorted capacitor: C106, C107, C109 or C110. b. Shorted rectifier: CR107. c. Blown fuse: F103.* d. Open resistor: R122 e. Faulty rectifier assembly: A103.
4.	No +24V output voltage. No fault signal.	a. Transformer open or shorted: T102.
5.	No +24V output voltage.	a. Faulty circuit card: A101.** b. Shorted capacitor: C113, C114, C115, C116, or C117. c. Shorted rectifier: CR101, CR102, CR110, or CR111. d. Open transistor: Q107. e. Blown fuse: F101.*
6.	No +6V output voltage. No fault signal.	a. Open transistor: Q111.
7.	Low output voltage: +6V output.	a. Open rectifier: CR103 or CR104.
8.	Low output voltage: -6V output.	a. Faulty rectifier assembly: A103. b. Shorted transistor: Q112 or Q113,
9.	Low output voltage: +24V output.	a. Open rectifier: CR101 or CR102.
10.	Low output voltage, loss of regulation: +6V output.	a. Shorted transistor: Q108, Q109, Q110 or Q111.
11.	High output voltage, loss of regulation: +6V output.	a. Shorted transistor: Q108, Q109, Q110, or Q111.
12.	High output voltage, loss of regulation: -6V output.	a. Open transistor: Q112 or Q113. b. Open resistor: R111 or R124.
13.	High output voltage, loss of regulation: +24V output.	a. Shorted transistor: Q101 through Q107.
14.	High ripple: +6V output.	a. Open capacitor: C103, C104, C105, or C108.
15.	High ripple: -6V output.	a. Open capacitor: C106 or C107. b. Faulty rectifier assembly: A103.
16.	High ripple: +24V output	a. Open capacitor: C101, C102, C103, C104, or C113.

* Installation and Adjustment section
** Maintenance section

Table 1-2. (Cont)
Troubleshooting Chart

Symptom	Possible Causes
17. Oscillation of +6V output.	a. Open capacitor: C108.
18. Oscillation of -6V output.	a. Open capacitor: C107.
19. Oscillation of +24V output.	a. Open capacitor: C113.
20. Erratic over-voltage operation: +24V output.	a. Open resistor: R116.
21. Erratic over-voltage operation: +6V output.	a. Open resistor: R113.
22. External circuit breaker open.	a. Shorted capacitor: C118.
23. Noise and spikes on line.	a. Open capacitor: C118.
24. Bendback of +24V output occurs at one-half of proper values.	a. Open resistor: R108 or R109.
25. Fan inoperative.	a. Fuse blown: F104.*
26. Poor transient response: +6V output.	a. Open capacitor: C111 or C112.
27. Poor transient response: -6V output.	a. Open capacitor: C109 or C110.
28. Poor transient response: +24V output.	a. Open capacitor: C114, C115, C116, or C117.
29. Fuse F101 blown.	a. Faulty circuit card: A101.** b. Shorted transistor: Q101 through Q107.
30. Fuse F102 blown.	a. Faulty circuit card: A102.** b. Shorted transistor: Q108 through Q111.
31. Fuse F103 blown.	a. -6V output shorted.
32. Fuse F104 blown.	a. Faulty fan motor.
33. Fuse F105 blown.	a. Shorted transformer: T101.

* Installation and Adjustment section
** Maintenance section

Overloaded Supply

If power supply overloading is suspected, remove connections to the load. If the supply then regulates, it was being operated above its overcurrent setting.

Power Supply Overheating

If the power supply becomes overheated, thermostat S102 will open. Check to see that proper cooling air is supplied to the power supply. (See Installation and Adjustment section.)

ELECTRICAL PARTS LIST

Electrical parts are listed in the following table. Detailed diagrams follow the listing.

Electrical Parts List, Model MP-40/MP-40E

Ref. Desig.	Description	Ault Part No.
	PR36-A2 or PR36-B1 Power Supply	
A101	CIRCUIT CARD ASSY: +24V Control	080-2457
A102	CIRCUIT CARD ASSY: ±6V Control	080-2410
A103	DIODE ASSY, SDA-10121	606-1031
B101	FAN, MUFFIN	628-1001
C101, 102	CAPACITOR: 5 μF, 660V	406-1312
C103, 104	CAPACITOR: 22,000 μF, 50V	400-1272
C105	CAPACITOR: 48,000 μF, 20V	400-1269
C106	CAPACITOR: 33,000 μF, 10V	400-1363
C107, 108	CAPACITOR: 5,000 μF, 10V	400-1243
C109, 110, 111 112	CAPACITOR: 100 μF, 10V	404-1045
C113	CAPACITOR: 1,200 μF, 50V	400-1244
C114, 115, 116, 117	CAPACITOR: 33 μF, 35V	404-1039
C118	CAPACITOR: 2 μF, 400V	406-1216
CR101, 102	DIODE: (Rectifier) Replacement type 40211	603-1200
CR103, 104	DIODE: (Rectifier) Replacement type 40109	603-1194

Ref. Desig.	Description	Ault Part No.
CR107	DIODE: (Rectifier) Replacement type 40208	603-1198
CR108	DIODE, SCR: Replacement type C30F	
CR109	DIODE: (Rectifier) Replacement type 40208	600-1029
CR110	DIODE: (Rectifier) Replacement type 40209	603-1198
CR111	DIODE, SCR: Replacement type C30F	603-1191
DS101	LAMP: GE WE51	600-1029
F101	FUSE: 20 amp	622-1095
F102	FUSE: 15 amp	622-1086
F103	FUSE: 5 amp	622-1085
F104	FUSE: 1/4 amp	622-1092
F105	FUSE: 15 amp (use 8 amp for 230V operation)	622-1086
Q101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111	TRANSISTOR: Replacement type 2N3055	601-1131
Q112	TRANSISTOR: Replacement type 2N3054	601-1161
Q113	TRANSISTOR: Replacement type 2N3055	601-1131
R101, 102, 103, 104, 105, 106	RESISTOR, WW: 0.25 ohms ±10%, 10W	580-5359
R107	RESISTOR, WW: 250 ohms ±5%, 5W	580-4123
R108,109,110	RESISTOR, WW: 0.1 ohm, ±10%, 25W	580-6601
R111	RESISTOR, WW: 3 ohms ±5%, 25W	580-6503
R112	RESISTOR, WW: 250 ohms ±5%, 20W	580-5758
R113	RESISTOR, CC: 200 ohms ±5%, 1/2W	500-1071
R114	RESISTOR, WW: 0.1 ohm ±10%, 10W	580-5360
R115	RESISTOR, WW: 0.25 ohm ±10%, 10W	580-5359
R116	RESISTOR, CC: 200 ohms ±5%, 1/2W	500-1071
R117, 118, 119	RESISTOR, WW: 0.25 ohm ±10%, 10W	580-5359
R120	RESISTOR, MF: 28.7K ±1%, 1/2W	530-2402

Ref. Desig.	Description	Ault Part No.
R121	RESISTOR, MF: 7.15K ±1%, 1/2W	530-2401
R122	RESISTOR, WW: 0.1 ohm ±5%, 10W	580-5360
R123	RESISTOR, WW: 100 ohms ±5%, 25W	580-6511
R124	RESISTOR, WW: 3 ohms ±5%, 25W	580-6503
S101	SWITCH, TOGGLE:	626-1031
S102	SWITCH (Thermostat)	626-1092
S103	SWITCH, WAFER	626-1022
T101	TRANSFORMER: (PR36-C1 only)	301-1306
	TRANSFORMER: (PR36-D1 only)	301-1338
T102	TRANSFORMER: (PR36-C1 only)	301-1172
	TRANSFORMER: (PR36-D1 only)	301-1253
	±6V Control Card Assy 080-2410	
C201	CAPACITOR: 0.01 µF, 200V	406-1133
C202	CAPACITOR: 0.0015 µF, 200V	406-1146
C203	CAPACITOR: 100 µF, 35V	400-1073
C204	CAPACITOR: 100 µF, 12V	400-1054
C205	CAPACITOR: 50 µF, 25V	400-1073
C206	CAPACITOR: 1.5 µF, 35V	404-1036
C207	CAPACITOR: 5 µF, 12V	400-1083
C208	CAPACITOR: 0.01 µF, 200V	406-1133
C209	CAPACITOR: 2 µF, 25V	400-1065
C210	CAPACITOR: 0.01 µF, 200V	406-1133
C211	CAPACITOR: 0.0022 µF, 200V	406-1136
C212	CAPACITOR: 100 µF, 35V	400-1541

Electrical Parts List, Model MP-40/MP-40E (Cont)

Ref. Desig.	Description	Ault Part No.
CR201, 202	DIODE: Replacement type 1N648	603-1172
CR203	DIODE: Replacement type 1N645	603-1171
CR204	DIODE, ZENER: Replacement type VR6A	605-1171
CR205, 206, 207	DIODE: Replacement type 1N645	603-1171
CR208	DIODE, ZENER: Replacement type 1N2163	605-1031
CR209, 210	DIODE, ZENER: Replacement type VR6A	605-1171
CR211	DIODE: Replacement type 1N645	603-1171
CR212	DIODE, SCR: Replacement type C6F	600-1065
CR213, 214, 215, 216, 217, 218, 219	DIODE: Replacement type 1N645	603-1171
CR220	DIODE, ZENER: Replacement Type 1N4754A	605-1206
CR221	DIODE, SCR: Replacement Type C6B	600-1066
CR222	DIODE, ZENER: Replacement Type 1N4752	605-1204
CR223	DIODE: Replacement Type 1N645	603-1171
Q201, 202	TRANSISTOR: Replacement type H204	601-1081
Q203	TRANSISTOR: Replacement type 2N3638	601-1151
Q204	TRANSISTOR: Replacement type 2N697	601-1051
Q205, 206	TRANSISTOR: Replacement type ME4002	601-1146
Q207	TRANSISTOR: Replacement type 2N697	601-1051
Q208	TRANSISTOR: Replacement type H204	601-1081
Q209	TRANSISTOR: Replacement type ME4002	601-1146
Q210	TRANSISTOR: Replacement type 2N697	601-1051
Q211	TRANSISTOR: Replacement type ME4002	601-1146
Q212, 213	TRANSISTOR: Replacement type 2N3638	601-1151
Q214	TRANSISTOR: Replacement type ME4002	601-1146
Q215	TRANSISTOR: Replacement type 2N3638	601-1151
R201	RESISTOR, CC: 100 ohms ±5%, 1/2 W	500-1065
R202	RESISTOR, CC: 620 ohms ±5%, 1/2W	500-1083
R203	RESISTOR, CC: 10K ±5%, 1/2W	500-1112
R204	RESISTOR, CC: (Value tailored to circuit) ±5%, 1/2W	500-XXXX
R205	RESISTOR, CC: 820 ohms ±5%, 1/2W	500-1086
R206	RESISTOR, CC: 430 ohms ±5%, 1/2W	500-1079

Ref. Desig.	Description	Ault Part No.
R207	RESISTOR, CC: 150 ohms ±5%, 1/2W	500-1068
R208	RESISTOR, CC: 10K ±5%, 1/2W	500-1112
R209	RESISTOR, CC: 470 ohms ±5%, 1/2W	500-1080
R210	RESISTOR, CC: 2.4K ±5%, 1/2W	500-1097
R211	RESISTOR, CC: 470 ohms ±5%, 1/2W	500-1080
R212	RESISTOR, CC: 6.8 ohms ±5%, 1/2W	500-1108
R213	RESISTOR, CC: 110 ohms ±5%, 1/2W	500-1065
R214	RESISTOR, CC: 1K ±5%, 1/2W	500-1088
R215	RESISTOR, CC: 470K ±5%, 1/2W	500-1152
R216	RESISTOR, POTENTIOMETER: 500 ohms, 1/2W	590-1086
R217	RESISTOR, MF: 560 ohms ±5%, 1/2W	530-2083
R218	RESISTOR, MF: 1.3K ±5%, 1/2W	530-2091
R219	RESISTOR, MF: 680 ohms ±5%, 1/2W	530-2084
R220	RESISTOR, CC: 2.4K ±5%, 1/2W	500-1097
R221	RESISTOR, CC: 270 ohms ±5%, 1/2W	500-1074
R222	RESISTOR, CC: 510 ohms ±5%, 1/2W	500-1081
R223	RESISTOR, CC: 3.9K ±5%, 1W	500-2102
R224	RESISTOR, CC: 560 ohms ±5%, 1/2W	500-1082
R225	RESISTOR, CC: 20K ±5%, 1/2W	500-1119
R226	RESISTOR, CC: 3K ±5%, 1/2W	500-1099
R227	RESISTOR, CC: 1K ±5%, 1/2W	500-1088
R228	RESISTOR, WW: 25 ohms ±5%, 3W	580-2762

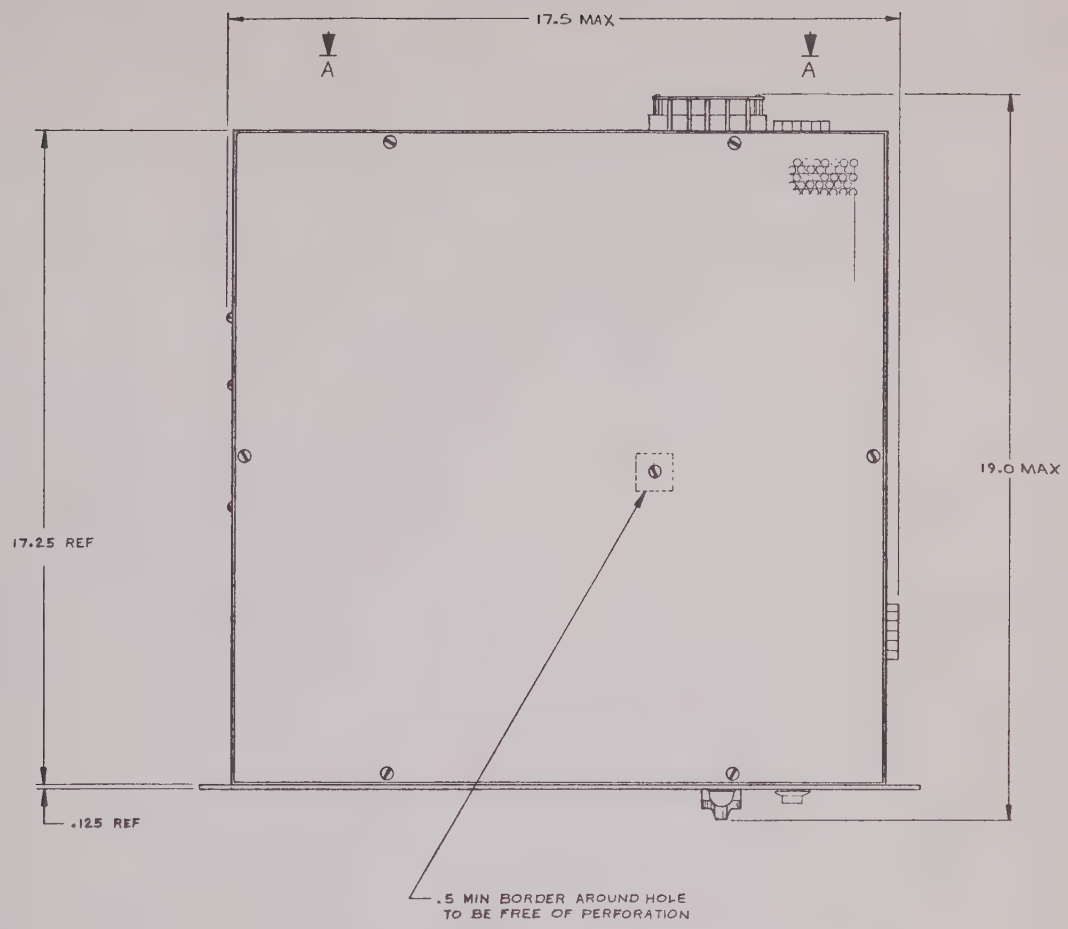
Ref. Desig.	Description	Ault Part No.
R229	RESISTOR, CC: 200 ohms ±5%, 1/2W	500-1071
R230	RESISTOR, CC: 2.4K ±5%, 1/2W	500-1097
R231	RESISTOR, CC: (Value tailored to circuit) ±5%, 1/2W	500-XXXX
R232	RESISTOR, CC: 1K ±5%, 1/2W	500-1088
R233	RESISTOR, CC: 20K ±5%, 1/2W	500-1119
R234	RESISTOR, CC: 1K ±5%, 1/2W	500-1088
R235	RESISTOR, CC: 5.1K ±5%, 1/2W	500-1105
R236	RESISTOR, CC: 16K ±5%, 1/2W	500-1117
R237	RESISTOR, CC: 10K ±5%, 1/2W	500-1112
R238	RESISTOR, CC: (Value tailored to circuit) ±5%, 1/2W	500-XXXX
R239	RESISTOR, CC: 1K ±5%, 1/2W	500-1088
R240	RESISTOR, CC: 100 ohms ±5%, 1/2W	500-1064
R241	RESISTOR, MF: 560 ohms ±5%, 1/2W	530-2082
R242	RESISTOR, POTENTIOMETER: 200 ohms, 1/2W	590-1087
R243	RESISTOR, CC: 1K ±5%, 1/2W	500-1088
R244	RESISTOR, CC: 5.1K ±5%, 1/2W	500-1105
R245	RESISTOR, CC: 10K ±5%, 1/2W	500-1112
R246	RESISTOR, CC: 1K ±5%, 1/2W	500-1088
R247	RESISTOR, CC: 100 ohms ±5%, 1/2W	500-1064
R248	RESISTOR, CC: 2K ±5%, 1/2W	500-1095
R249	RESISTOR, POTENTIOMETER: 5K, 1/2W	590-1090
R250	RESISTOR, CC: 100 ohms ±5%, 1W	500-2064

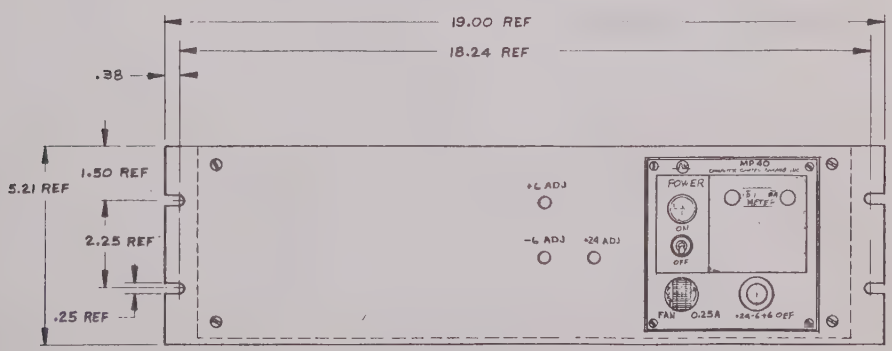
Ref. Desig.	Description	Ault Part No.
R251	RESISTOR, CC: 1K ±5%, 1/2W	500-1088
R252	RESISTOR, CC: 100 ohms ±5%, 1/2W	500-1064
	+24V Control Card Assy 080-2461	
C301	CAPACITOR: 0.0022 μF, 200V	406-1136
C302	CAPACITOR: 1.5 μF, 35V	404-1036
C303	CAPACITOR: 0.0022 μF, 200V	406-1136
C304	CAPACITOR: 0.01 μF, 200V	406-1133
C305, 306	CAPACITOR: 50 μF, 25V	400-1073
CR301	DIODE: Replacement Type 1N645	603-1171
CR302	DIODE, ZENER: Replacement Type 1N936	605-1191
CR303, 304	DIODE: Replacement Type 1N645	603-1171
CR305	DIODE, ZENER: Replacement Type VR6A	605-1171
CR306, 307	DIODE: Replacement Type 1N645	603-1171
CR308	DIODE, ZENER: Replacement Type VR6A	605-1171
CR309	DIODE: Replacement Type 1N645	603-1171
CR310	DIODE, ZENER: Replacement Type 1N2163	605-1031
CR311, 312, 313, 314	DIODE: Replacement Type 1N645	603-1171
Q301, 302	TRANSISTOR: Replacement Type H204	601-1081
Q303	TRANSISTOR: Replacement Type 2N697	601-1051
Q304	TRANSISTOR: Replacement Type 2N3877	601-1172
Q305, 306	TRANSISTOR: Replacement Type H204-3	601-1082
Q307	TRANSISTOR: Replacement Type H204	601-1081
Q308	TRANSISTOR: Replacement Type 2N697	601-1051
Q309	TRANSISTOR: Replacement Type 2N3440	601-1171
Q310, 311, 312	TRANSISTOR: Replacement Type 2N697	601-1051
Q313	TRANSISTOR: Replacement Type H204	601-1081
Q314	TRANSISTOR: Replacement Type 2N697	601-1051
R301	RESISTOR, CC: 91 ohms ±5%, 1/2W	500-1063

Electrical Parts List, Model MP-40/MP-40E (Cont)

Ref. Desig.	Description	Ault Part No.
R302	RESISTOR, CC: 10K ±5%, 1/2W	500-1112
R303	RESISTOR, CC: ±5%, 1/2W (Value tailored to circuit)	500-XXXX
R304	RESISTOR, CC: 2K ±5%, 1/2W	500-1095
R305	RESISTOR, CC: 10K ±5%, 1/2W	500-1112
R306	RESISTOR, CC: 16K ±5%, 1/2W	500-1117
R307	RESISTOR, CC: 1K ±5%, 1/2W	500-1088
R308	RESISTOR, CC: 750 ohms ±5%, 1/2W	500-1085
R309	RESISTOR, CC: 2K ±5%, 1/2W	500-1095
R310	RESISTOR, CC: 2.4K ±5%, 1/2W	500-1097
R311, 312	RESISTOR, CC: 10K ±5%, 1/2W	500-1112
R313	RESISTOR, CC: 9.1K ±5%, 1/2W	500-1111
R314	RESISTOR, POTENTIOMETER: 2K ±5%, 1/2W	590-1089
R315	RESISTOR, CC: 7.5K ±5%, 1/2W	500-1109
R316, 317	RESISTOR, CC: 5.1K ±5%, 1/2W	500-1105
R318	RESISTOR, MF: 30K ±5%, 1/2W	500-1123
R319	RESISTOR, CC: 2K ±5%, 1/2W	500-1095
R320	RESISTOR, CC: 10K ±5%, 1/2W	500-1112
R321	RESISTOR, CC: 20K ±5%, 1/2W	500-1119
R322	RESISTOR, CC: 5.1K ±5%, 1/2W	500-1105
R323	RESISTOR, CC: 1.2K ±5%, 1/2W	500-1090
R324	RESISTOR, CC: 10 ohms ±5%, 1/2W	500-1040
R325	RESISTOR, CC: 10K ±5%, 1/2W	500-1112

Ref. Desig.	Description	Ault Part No.
R326	RESISTOR, CC: 1.8K, 1/2W	500-1094
R327	RESISTOR, CC: 430 ohms ±5%, 1/2W	500-1079
R328	RESISTOR, CC: 100 ohms ±5%, 1/2W	500-1064
R329, 330	RESISTOR, CC: 10K ±5%, 1/2W	580-1112
R331	RESISTOR, CC: 470 ohms ±5%, 1/2W	500-1152
R332	RESISTOR, CC: 6.2K ±5%, 1/2W	500-1107
R333	RESISTOR, MF: 2.21K ±1%, 1W	533-3303
R334	RESISTOR, CC: 270 ohms ±5%, 1/2W	500-1074
R335	RESISTOR, CC: 3K ±5%, 1/2W	500-1099
R336	RESISTOR, MF: 910 ohms ±1%, 1W	530-3087
R337	RESISTOR, CC: 3.9K ±5%, 1/2W	500-1102
R338	RESISTOR, POTENTIOMETER: 1K, 1/2W	590-1088
R339	RESISTOR, CC: ±5%, 1/2W (Value tailored to circuit)	500-XXXX
R340	RESISTOR, CC: 300 ohms ±5%, 1/2W	500-1075
R341	RESISTOR, CC: 1K ±5%, 1/2W	500-1088
R342, 343	RESISTOR, CC: 500 ohms ±1%, 1W	580-1053
R344	RESISTOR, CC: 3.9K ±5%, 1W	500-2102
R345	RESISTOR, MF: 2K ±1%, 1W	530-3302
R346	RESISTOR, CC: 10K ±5%, 1/2 W	500-1112





⚠-CONNECT A THERMISTOR (3C PART NO. 932 300 004) TO EITHER OF THE R_T TERMINALS BEFORE OPERATING.

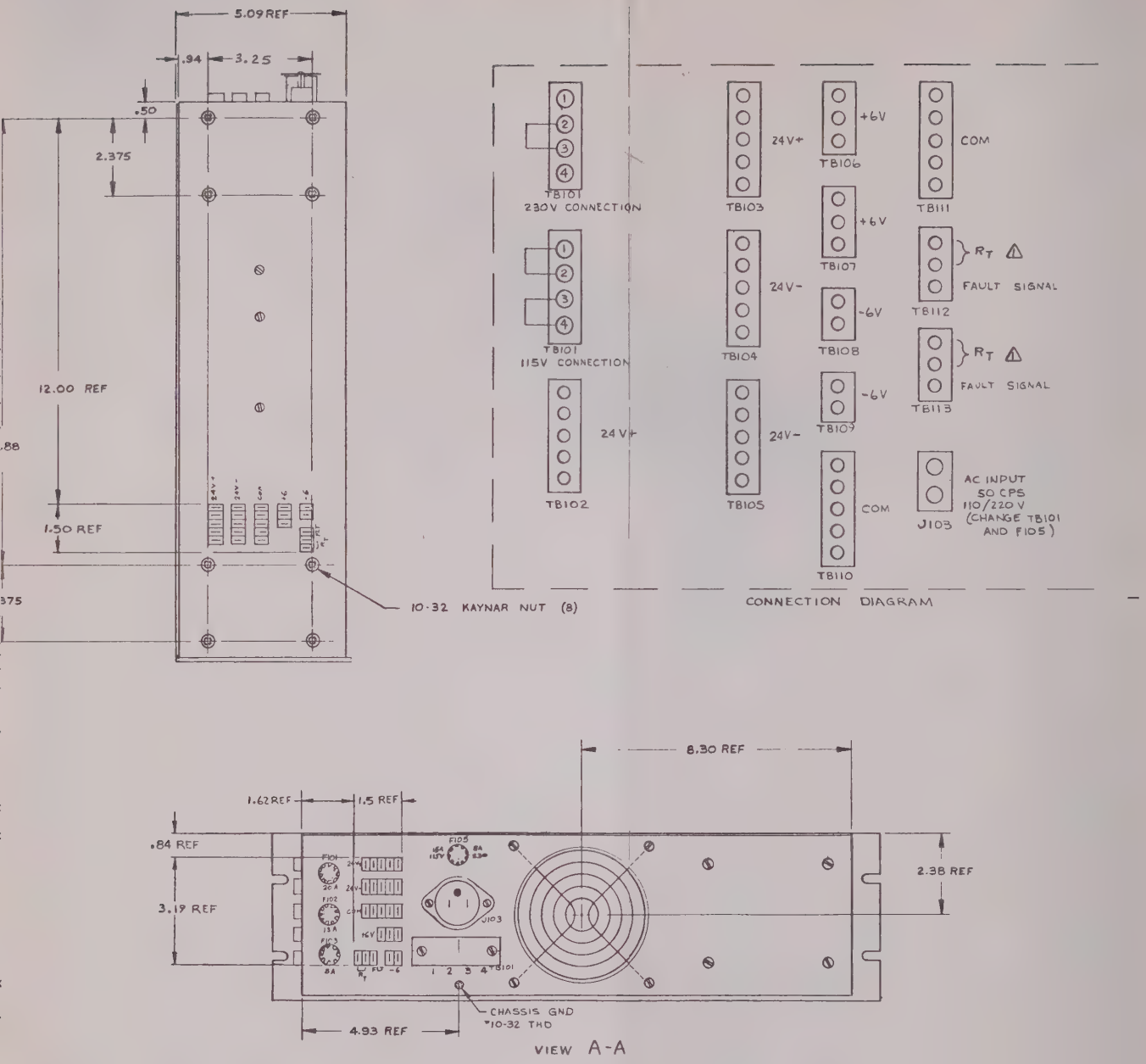
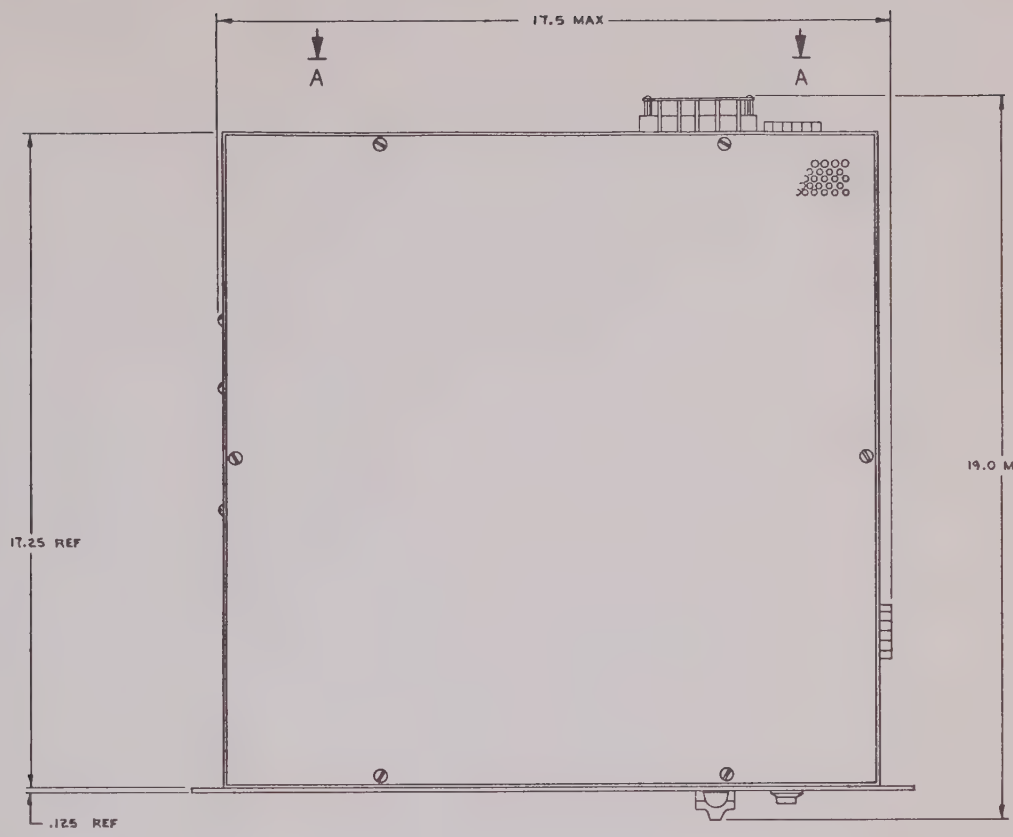
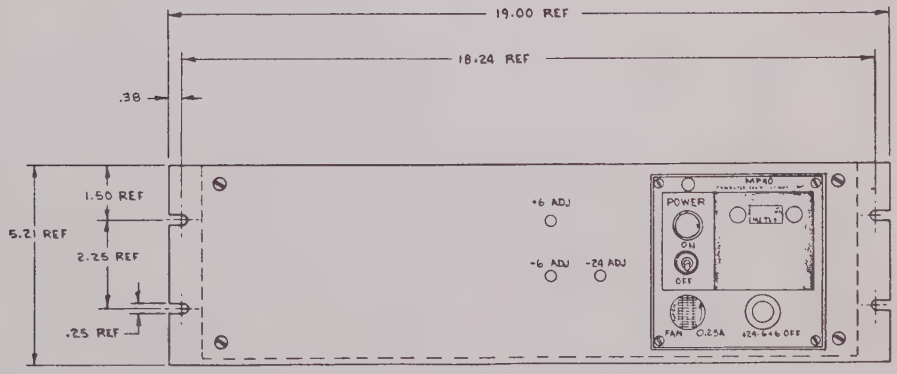


Figure 1-43. Power Supply, Model MP-40/ MP-40E, Installation Drawing PR36-D1-1 (Sheet 1 of 2)





⚠ - CONNECT A THERMISTOR (3C PART NO.932300004) TO EITHER OF THE RT TERMINALS BEFORE OPERATING.

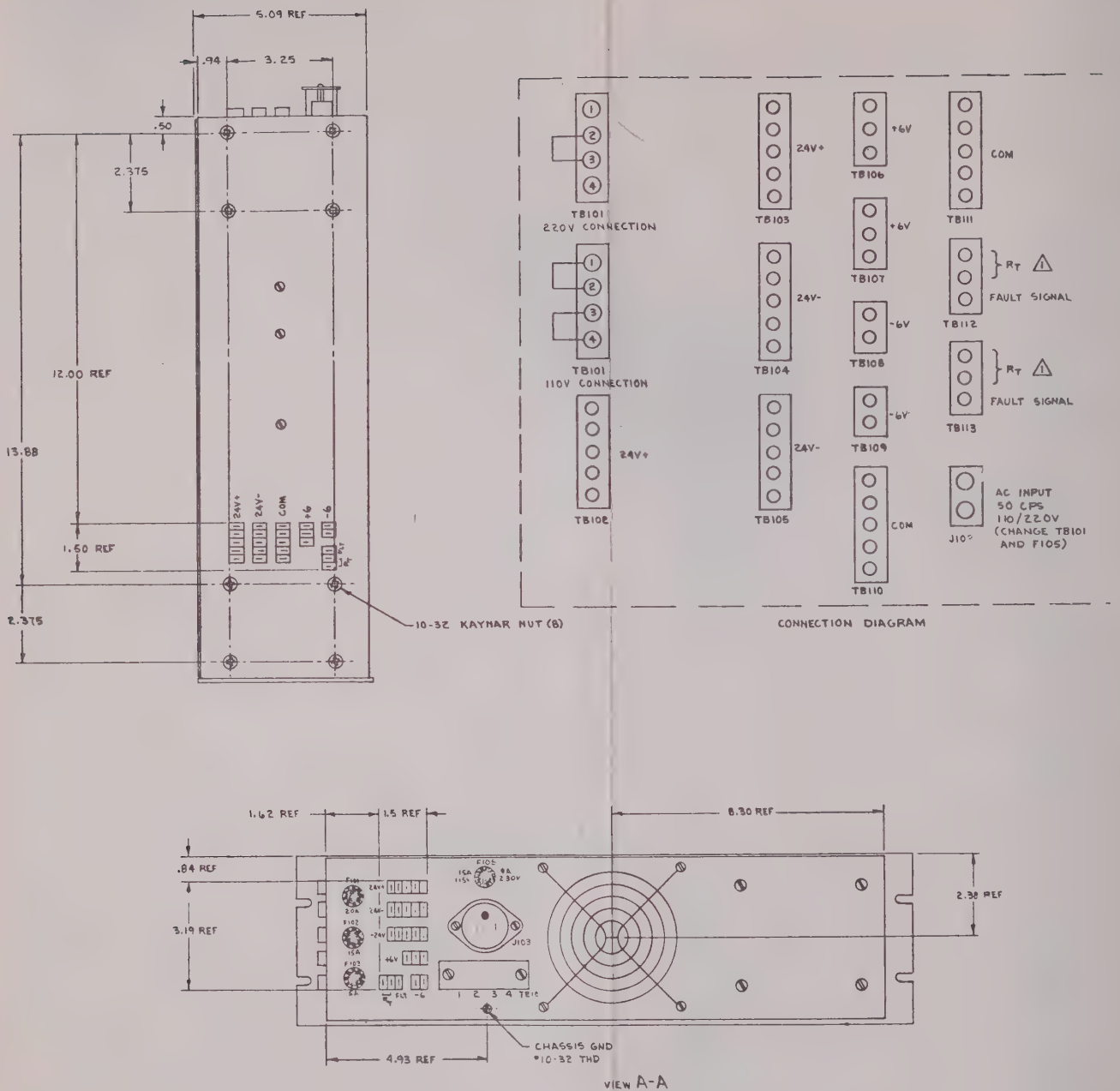
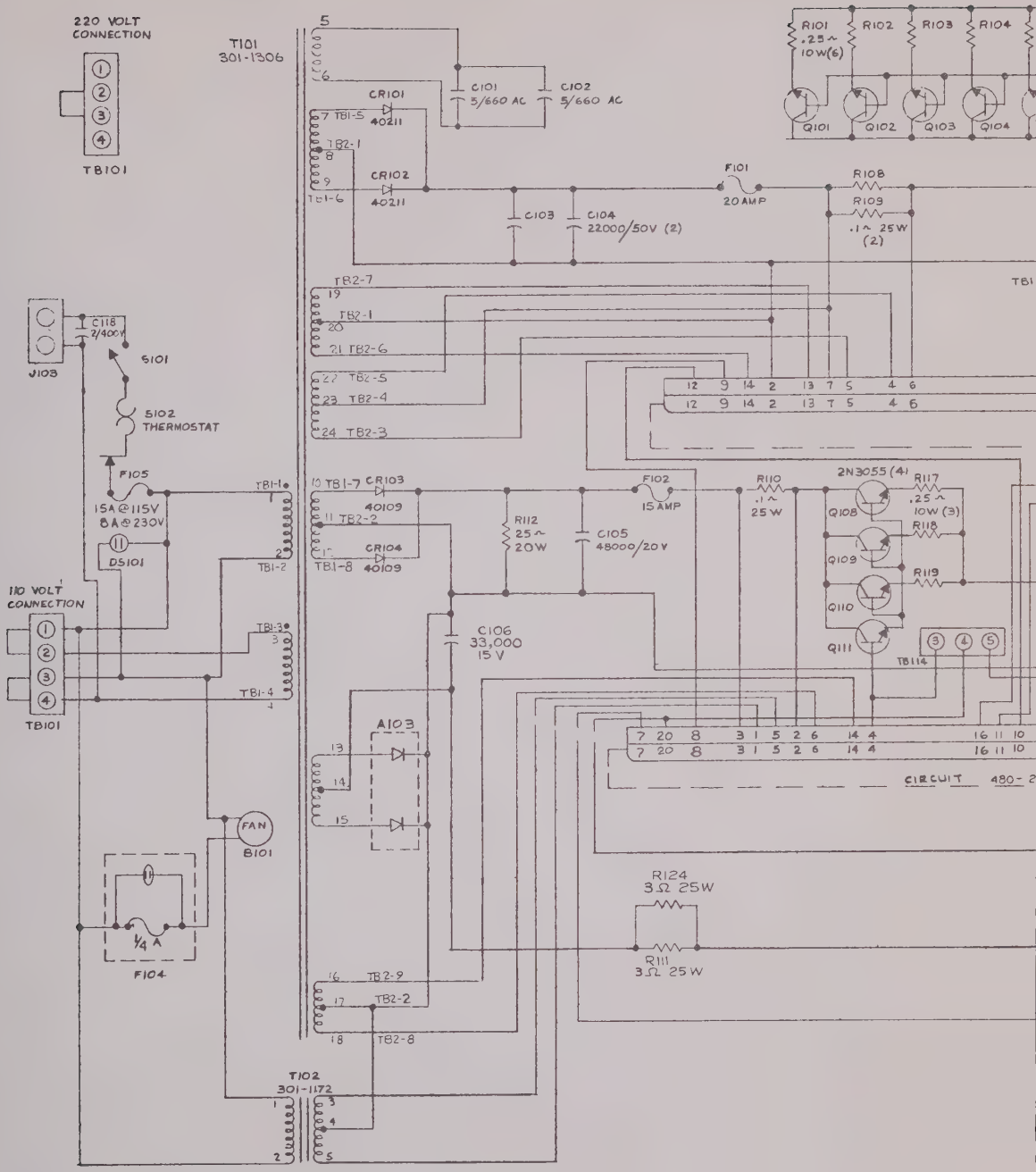


Figure 1-43. Power Supply, Model MP-40/ MP-40E, Installation Drawing PR36-D1-1 (Sheet 2 of 2)



1-ALL RESISTANCES ARE ½W IN OHMS & ALL CAPACITANCES ARE IN UF UNLESS OTHERWISE SPECIFIED.

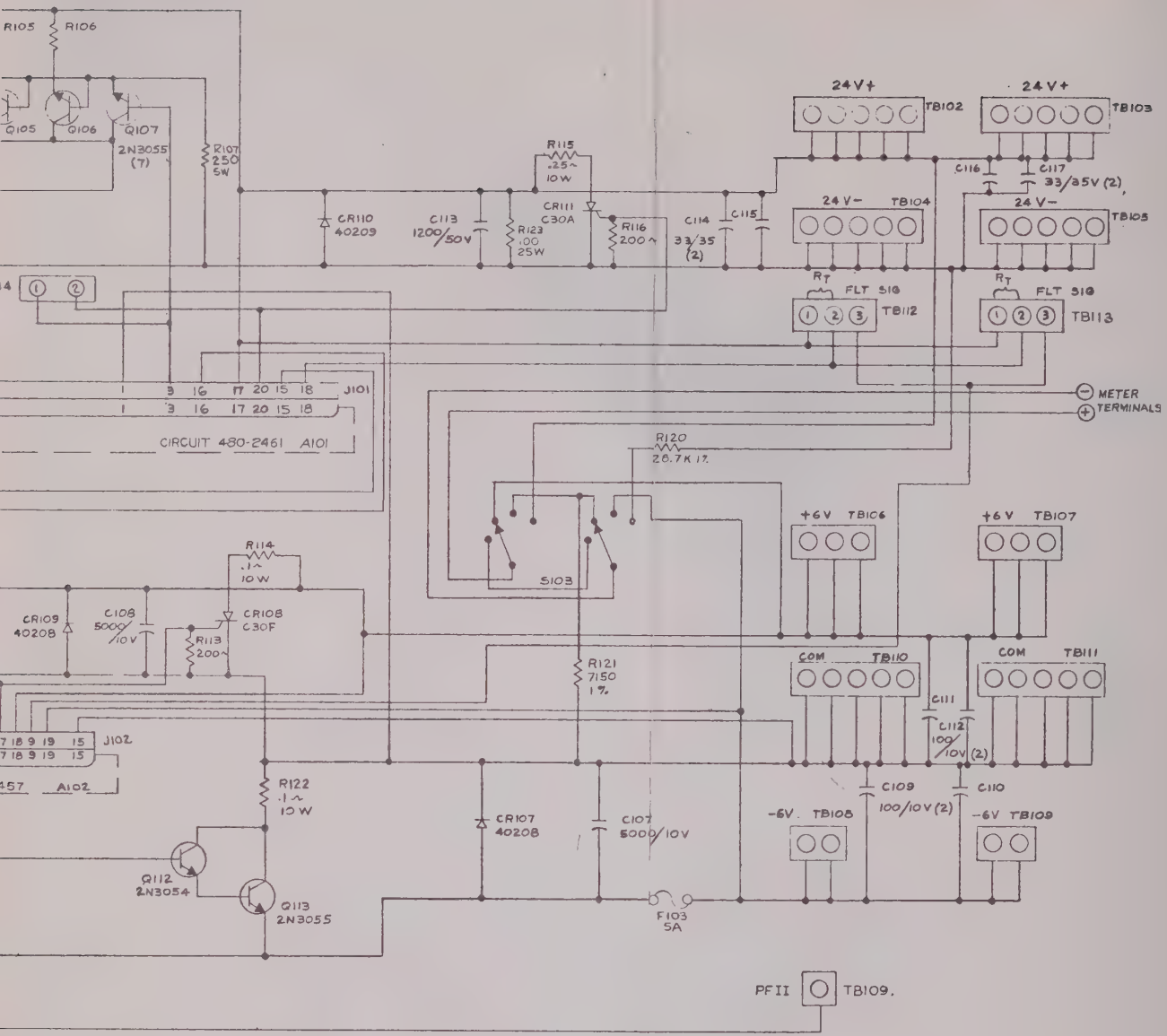
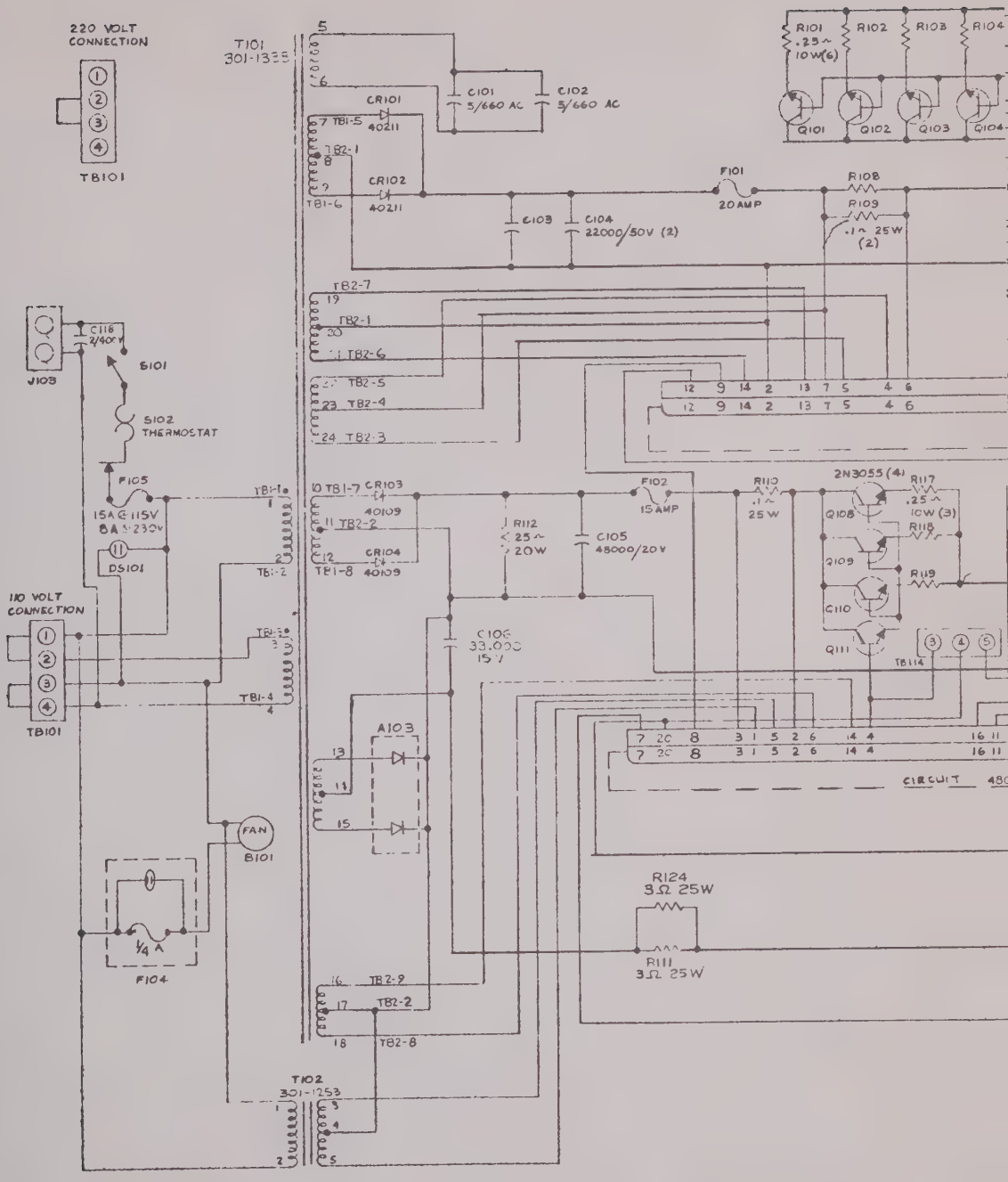


Figure 1-44. MP-40 Power Circuit, 60 Hz, Schematic Diagram, PR36-C1-2 (Sheet 1 of 2)



1- ALL RESISTANCES ARE ½W IN OHMS & ALL CAPACITANCES ARE IN UF UNLESS OTHERWISE SPECIFIED.

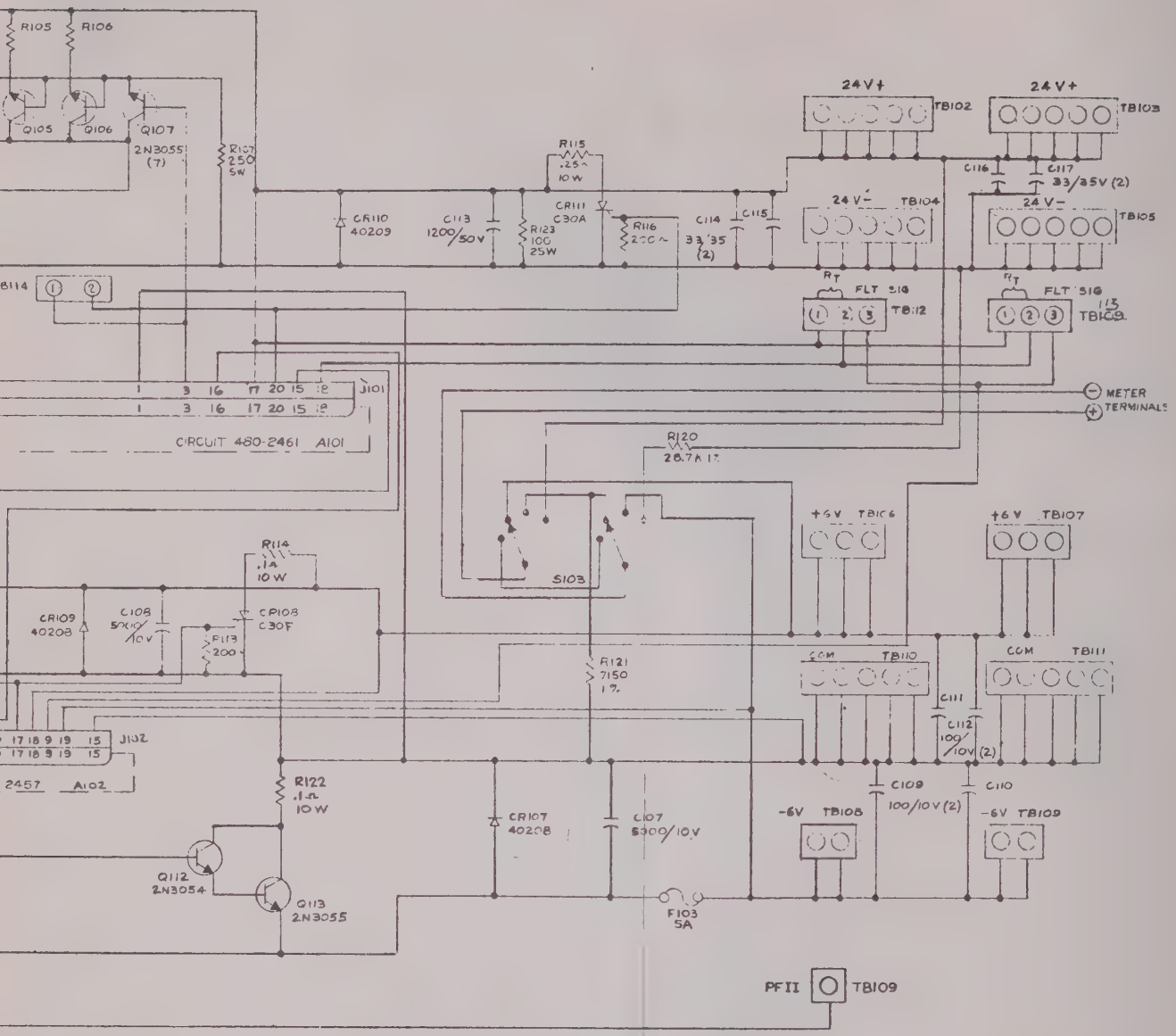
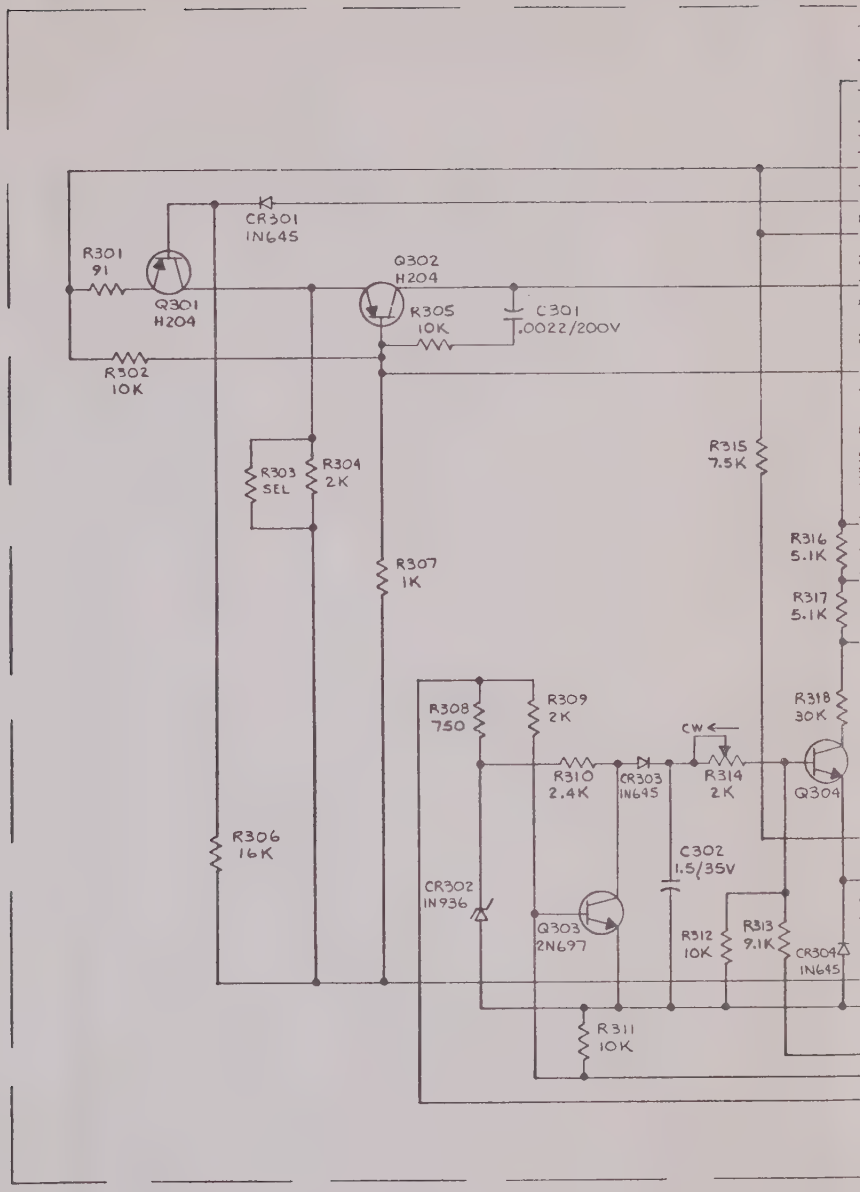


Figure 1-44. MP-40 Power Circuit, 60 Hz, Schematic Diagram, PR36-D1-2 (Sheet 2 of 2)



1-ALL RESISTANCES ARE ½W IN OHMS & ALL CAPACITANCES ARE IN UF UNLESS OTHERWISE SPECIFIED.

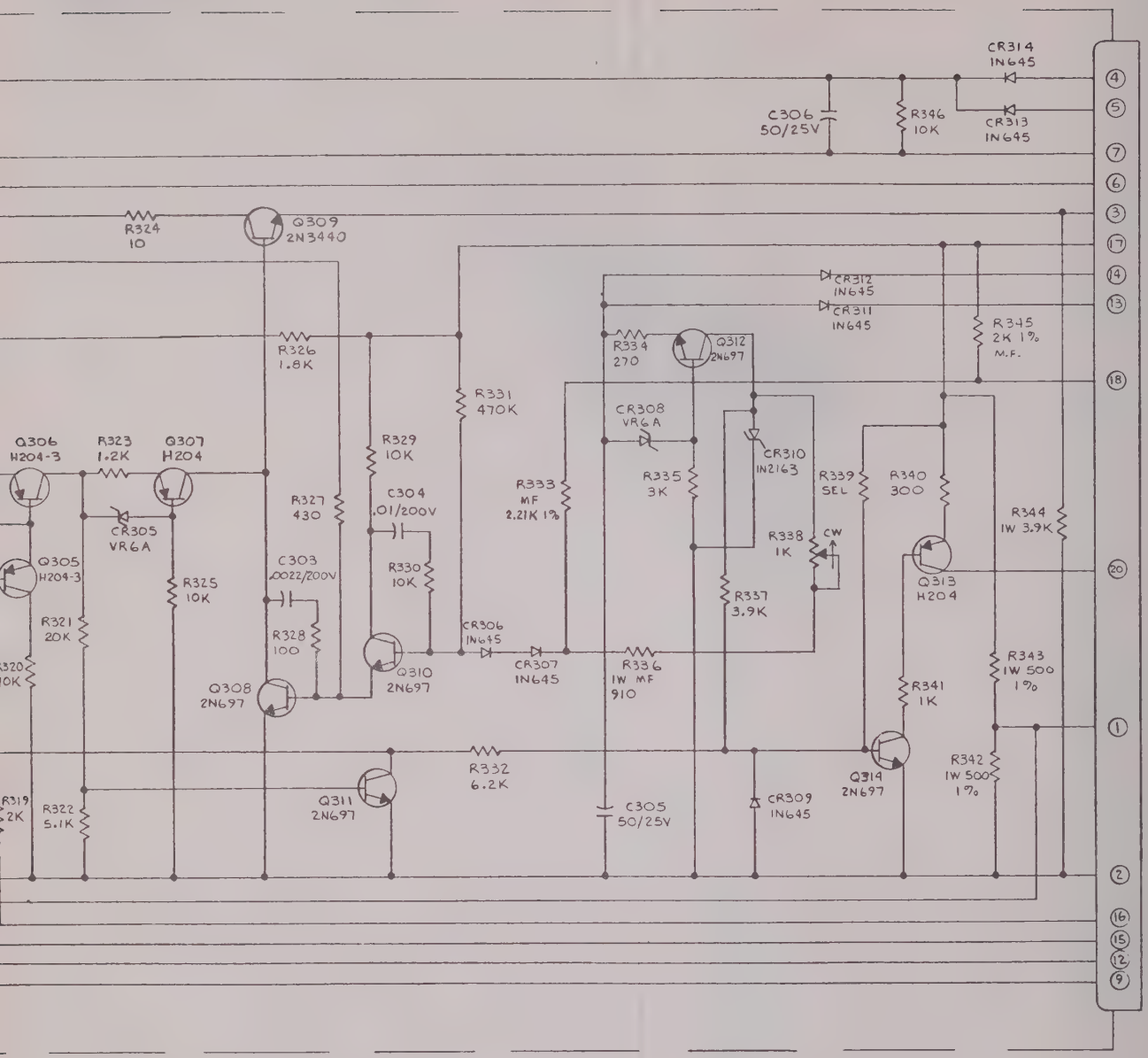
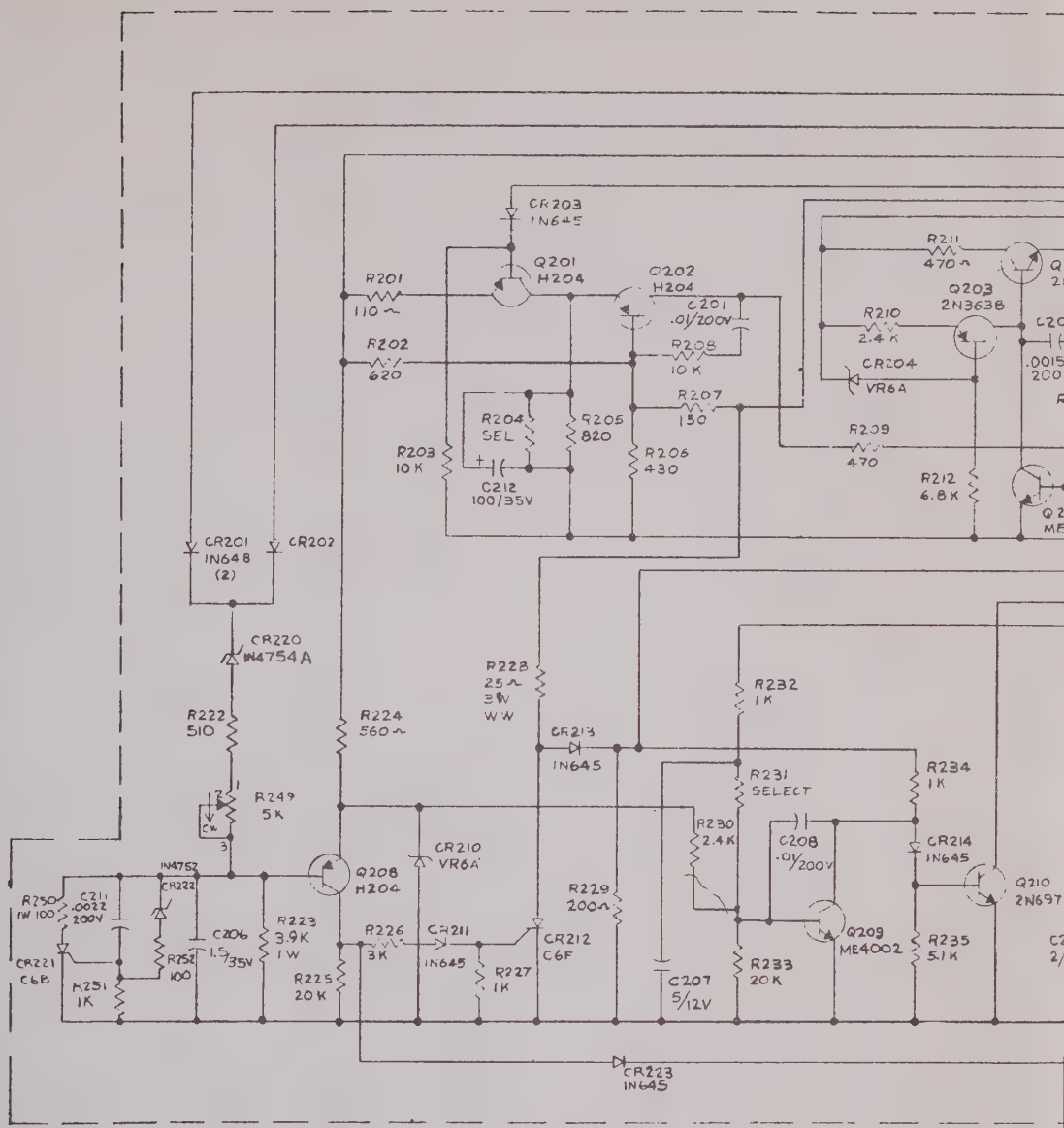


Figure 1-45. +24V Control Circuit, Schematic Diagram (480-2461)



1- ALL RESISTANCES 1/2W IN OHMS AND ALL CAPACITANCES ARE IN UF UNLESS OTHERWISE SPECIFIED.

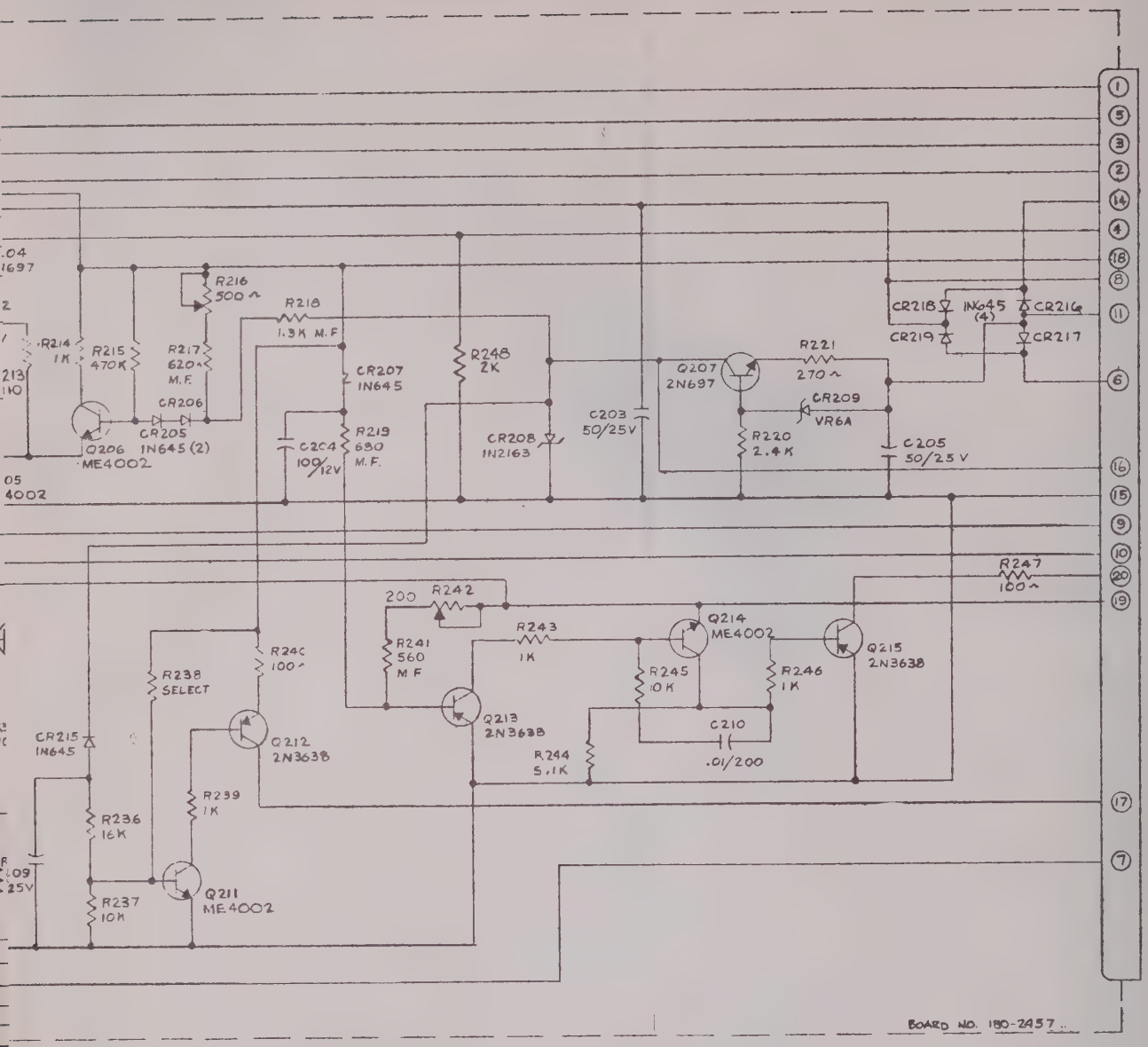


Figure 1-46. ±6V Control Circuit, Schematic Diagram (480-2457)

PART II

Power Supply

North Electric Company

PART II
MP-40/40E POWER SUPPLY (NORTH ELECTRIC)*

INTRODUCTION

The MP-40 (PEC-3184) and the MP-40E (PEC-3184 A) power supplies are the same except for the input frequency. The MP-40 operates at 60 ±1 Hz, single phase, 95 - 130 Vac or 190 - 260 Vac. The MP-40E operates at 50 ±1 Hz, single phase, 95 - 130 Vac or 190 - 260 Vac.

The supply has three main outputs: 24 Vdc rated at 13 amperes average, +6 Vdc rated at 10 amperes average, and -6 Vdc rated at 1.5 amperes average. These voltages are generated using solid state circuitry only and are designed to meet Honeywell 3C Specification 10083B.

The MP-40 and MP-40E are multiple-output power supplies that are designed to meet Honeywell Inc. 3C Specification 10083B. All outputs are fused and protected from overvoltage. Current limiting is provided without blowing output fuses. The units are also protected against unsafe operating temperatures by a thermal switch, which blows the input fuse and removes the input voltage. The outputs of the supplies are connected to duplicate Heyco connectors at the back and side for vertical or horizontal mounting of unit.

A meter control panel, which can be mounted in the unit in a vertical or horizontal position, houses meter jacks (meter is optional), a switch to monitor the output voltages, a power OFF-ON switch, an indicating fuse for the blower that is mounted in the unit, and a power on lamp which indicates that ac input voltage is present. Adjustments for all outputs are located on the front panel.

A 4 - 6 Vdc fault indication voltage is provided that indicates the condition of the input line. It is adjusted to drop out when the input reaches 93 - 102 Vac. The adjustment is performed by a trimpot on the fault circuit card. The voltages are sequenced on and off to meet Honeywell 3C Specification 10083B.

* The information in this section is presented with the permission of the manufacturer, North Electric Company, 570 S. Market Street, Galion, Ohio, 44833.

OPERATING PROCEDURE

CONTROLS AND ADJUSTMENTS

A. R28 24 Vdc Output
*B. R35 24 Vdc Current Limit
C. R45 24 Vdc Slope
D. R25 24 Vdc Bridge Balance
E. R62 +6 Vdc Output
*F. R67 +6 Vdc Current Limit
G. R82 -6 Vdc Output
*H. R86 -6 Vdc Current Limit
I. R102 24 Vdc Delay
J. R108 Line Fault
*K. R115 Fault Trigger
*L. R120 Fault Drop Out

PRELIMINARY PROCEDURES

The MP-40 and MP-40E power supplies are identical except for the input frequency. The remainder of this manual will describe the MP-40, which is designed for 60 Hz operation. When operating an MP-40E, remember that the input is 50 Hz.

1. Connect input power to connector J103. As shipped, the unit is wired for 115 Vac operation. For 220 Vac operation, see wiring chart in the schematic drawing.

2. Check the 24 volt output with a 3910 ohm resistor across terminals R_T of TB112 or TB113 on the back or side of the unit. It is adjustable by potentiometer R28 on the front panel.

3. The ±6 Vdc outputs are adjustable by potentiometers R62 (+6) and R82 (-6) on the front panel.

4. Peak-to-peak ripple on all outputs will be less than 1 percent.

5. The fault voltage signal of 4 - 6 Vdc is read between the terminal marked FAULT SIGNAL (TB112 or TB113), and the dc common terminal strip TB110 or TB111.

*Factory setting only

CURRENT LIMITS

Each supply has an adjustable current limit with a fold-back feature, which enables it to sustain a short circuit for an indefinite period of time. The current limit is set at the factory to enable each output to sustain a short circuit without blowing the output fuse and to recover automatically when the short is removed.

Current Limit Test

Each of the current limits is checked by slowly reducing the output load resistance until the output current reaches a droop point, which is the maximum current that the supply will pass.

CAUTION

Do not increase the load current past 120 percent of peak current. Current limits are factory set to droop between full load and 120 percent of peak current. Any further decrease in the load resistance will decrease the load current after passing the droop point until a complete short circuit is applied to the output. Removal of the short circuit will allow the supply to recover to its normal operating condition. If the current limit droop point does not occur before 120 percent of rated peak current, stop at this point. Adjust the appropriate potentiometer in a clockwise direction until the current droops and continue with the test. If the droop occurs too soon, adjust the appropriate trimpot in the counter-clock-wise direction. This will move the droop to a higher value.

OVERVOLTAGE PROTECTION

Each output, except the fault voltage, has an overvoltage protection circuit that prevents the output voltage from exceeding specified limits. Each output overvoltage is preset and has no adjustment.

Overvoltage Tests

The same procedure is used to check the overvoltage of each output. A SCR silicon-controlled rectifier diode crowbars when the voltage reaches a predetermined value. Since the voltage needed to fire the SCR is higher than the adjustable range, a method of raising the output or changing this range must be used in testing.

One method is to shunt the pass transistors for the output under test with a rheostat. By gradually decreasing the resistance of the shunt, the output will be increased to the firing point of the SCR diode. If this method is used, replace the output fuse of the supply being tested with a circuit breaker rated no higher than the output being tested as shown in Figure 2-1. By monitoring the output with a dc voltmeter, while decreasing the shunt resistance, an accurate check can be made on the overvoltage firing point. Check each output in this manner. The output voltage should not exceed 32.6 Vdc for the 24 volt supply and ±7.8 Vdc for the ±6 volt supply.

SEQUENCING OF OUTPUTS

The turn-on time and turn-off time as specified in Honeywell 3C Specification 10083B is maintained for any combination of line and load.

Power On

Turn-on of the 24 Vdc supply is delayed so that the ±6 volt outputs exceed 90 percent of their nominal value before the 24 volt output reaches 20 percent of its nominal value. The ±6 Vdc outputs are energized when ac power is applied. Their relative sequence is not restricted.

To check for proper sequencing when ac power is applied, use a Tektronix dual trace oscilloscope or equivalent with a dual trace type CA plug-in on the chopped position. Use the following procedure.

1. Connect the bottom set of leads (B) from the -24 volt output (TB104 or TB105) to the +24 volt output (TB102 or TB103). Connect the top set of leads (A) from dc common (TB110 or TB111) to the +6 volt output (TB106 or TB107).

2. Place the external trigger lead (+ side only) to the load side of power switch S1.

CAUTION

Check scope input for an isolation plug during this test. Do not continue this test unless scope is isolated from ac input.

Place the scope trigger mode on external trigger. By adjusting the trigger slope to trigger the scope when ac power is applied to the unit with power switch S1, the ON time comparison can be seen.

3. To check the -6 volt output, move the A lead from the +6 volt output (TB106 or TB107) to the -6 volt output (TB108 or TB109) and move the polarity switch on the scope to the inverted position. The ON-time waveforms will be similar to Figure 2-2 when ac power is applied by placing the POWER switch to the ON position.

Power Off

On turn-off or loss of ac power, the ±6 volt outputs shall remain in the regulation band until the 24 volt output has decreased to less than 20 percent of its nominal value. To check for proper sequencing when ac input power is lost, use the procedure described in the Power On check except that the scope must be triggered when POWER switch S1 is moved to the OFF position. Resultant waveforms will be similar to those shown in Figure 2-3.

Line Fault Circuit

A signal is also provided on the output to indicate that the ac line voltage is within acceptable limits. It is called the fault voltage and is a 4 to 6 Vdc signal rated at 10 milliamperes.

Following a loss of ac power, the fault voltage should fall to ground or dc common within 15 milliseconds after the last ac peak above 93 Vac, when on 115 Vac operation; or

after the last peak above 186 Vac, when on 220 Vac operation. Potentiometer R108 on the fault circuit card adjusts the fault voltage dropout level at 102 Vac for 115 Vac operation, or 204 Vac for 220 Vac operation. When the fault signal is adjusted for 102 or 204 Vac, it must fall to ground within 10 milliseconds after turn-off. The 24 volt output is also sequenced down when the fault voltage is lost. A drop in the 24 volt output must be delayed by 1 millisecond after the fault voltage falls to ground; and it should decrease to or less than 50% of its nominal value within 2 milliseconds. Potentiometer R102 on the fault circuit card adjusts the time delay.

Use the following procedure to check the time of the fault voltage dropout and the delay of the 24 Vdc output.

1. Use a Tektronix dual trace oscilloscope or equivalent with a dual trace type CA plug-in on the chopped position.

2. Connect the top set of leads (A) across the 24 Vdc output. Connect the bottom set of leads (B) from the fault voltage (+) to dc common (-).

3. Set the input line to high line condition.

4. Trigger the oscilloscope by moving POWER switch S1 to the OFF position. The resultant waveforms should be similar to those shown in Figure 2-4.

Thermistor Check

The output voltage level of the 24 volt supply is temperature compensated by an external thermistor connected across terminals R_T of TB112 or TB113. This thermistor (3C Part No. 932 300 004) has a nominal value of 4700 ohms at 25°C. Its resistance varies inversely with temperature; therefore, changes in the thermistor ambient temperature vary the output voltage.

The thermistor can be simulated by placing a 4700 ohm resistor across the R_T terminals on the back or side of the power supply. Adjust R28 on the front panel to 24 Vdc output. With the 4700 ohm resistor in place of the thermistor, load the 24 volt output to full load. Check the voltage across the blue and slate colored test jacks on the 24V printed circuit card (PC-1). If the voltage across these test jacks does not read 0 ±10 millivolts, adjust potentiometer R25 until it does. This simulates the thermistor action at 25°C.

With the output set at 24 Vdc, and 0 ±10 millivolts measured across the blue and slate colored test jacks on PC-1, remove the 4700 ohm resistor and replace it with a 9000 ohm resistor. This simulates the thermistor action for a change in its ambient temperature from 25°C to 10°C. The output voltage should read 25.8 Vdc ±4 percent. Replace the 9000 ohm resistor with a 1200 ohm resistor to simulate thermistor action for a change in temperature from 10°C to 60°C. The output should read 19.8 Vdc ±2 percent.

REGULATION

For regulation limits and specifications, see Honeywell 3C Specification 10083B.

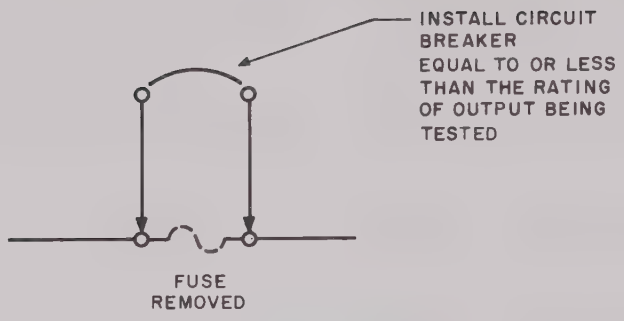


Figure 2-1. Installation of Circuit Breaker for Overvoltage Test

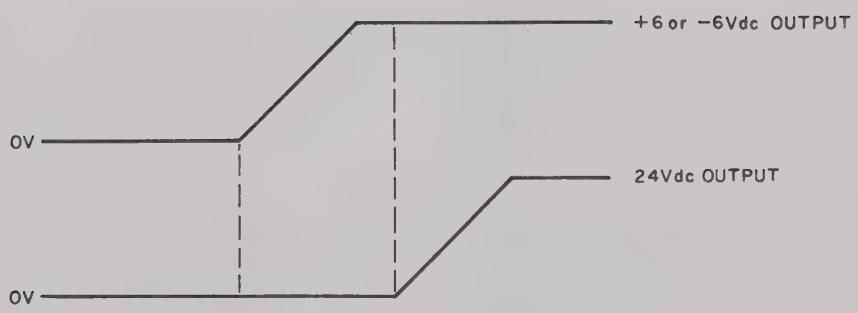


Figure 2-2. Signal Waveforms for Power On Test

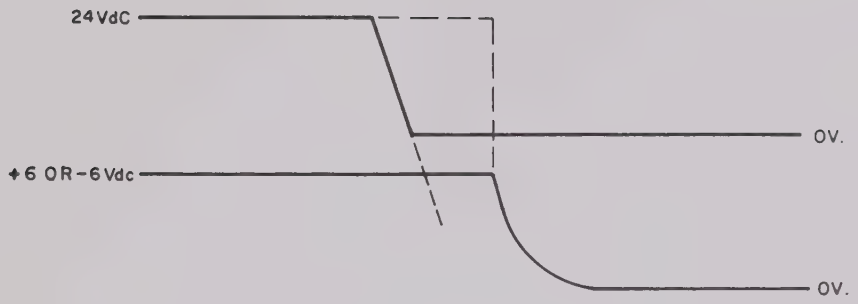


Figure 2-3. Signal Waveforms for Power Off Test

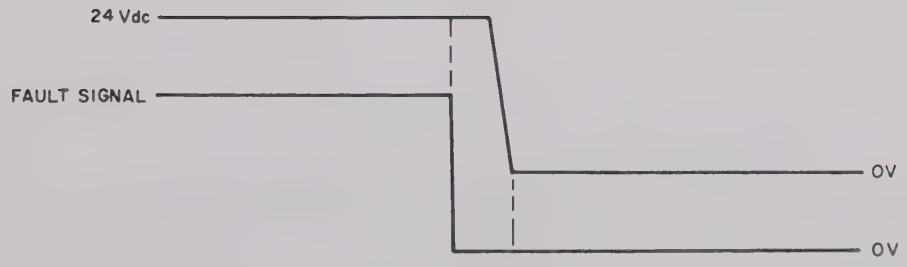


Figure 2-4. Signal Waveforms for Fault Voltage Test

FUNCTIONAL DESCRIPTION

AC POWER INPUT CIRCUIT

The ac input circuit includes switch S1, fuse F1, thermoswitch TS1, resistor R1, input plug J103, fuse F3 and blower B1.

Switch S1 controls input ac power to the primary of ferro regulator VR1. F1 protects the input circuit against excessive current. It is rated at 10A at 115V or 5A at 230V.

Thermoswitch TS1 and resistor R1 form a thermal cut-out circuit that removes the input voltage from VR1, when safe operating temperature is exceeded.

Terminal block TB101 on the back of the unit connects directly to the primary of ferro regulator VR1. By wiring TB101 as shown in the chart on the schematic drawing, either 110 Vac or 220 Vac input power can be used. Blower B1 provides forced air for cooling the unit. Fuse F3, rated at 0.25A, protects the blower motor against excessive current. It has an associated lamp mounted on the meter control panel that illuminates when the fuse has blown.

VR1 REGULATOR AND BULK SUPPLIES

The ferro regulator is a constant voltage transformer. It produces secondary voltages that are nearly constant, varying only ±1 percent for a ±10 percent change in input. Primary winding terminals 5 and 6 of the VR1 are connected to capacitor C5 which forms a resonant circuit for the ferro-regulator. The remaining windings are described below and are secondaries unless otherwise noted.

Winding Terminal No.	Purpose
13 - 14 - 15	Dual bias for 24 volt circuit.
7 - 8 - 9	Preregulated bulk voltage for 24V regulator circuit.
19 - 20 - 21	Supplies bulk voltage for zenered slope voltage.
25 - 26 - 27	Dual bias for +6 volt circuit.
10 - 11 - 12	Preregulated bulk voltage for +6 volt regulator circuit.
28 - 29 - 30	Single bias for -6 volt circuit.
16 - 17 - 18	Preregulated bulk voltage for -6 volt regulator.
22 - 23 - 24	Serves as voltage to operate sequencing circuit.
31 - 32 - 33	Primary voltage sensed by the line fault circuit to monitor the condition of the input line.

Each secondary voltage is full wave rectified capacitor filtered to reduce the ripple.

±6 VOLT REGULATORS

Functionally, the +6 volt and the -6 volt regulators are nearly identical so that only the +6 volt regulator is described. The +6 volt regulator has an additional amplifier and additional pass transistors because of the greater current requirement.

Zener diode CR30 furnishes a reference voltage for the regulator. Resistors R58 and R59 form a divider to set the base of transistor Q23 at a nominal reference point. Resistor R60 provides current limiting for zener diode CR30. Precision resistors R61 and R63 and potentiometer R62 form a sensing network that compares a portion of the output to the reference voltage.

Transistors Q23 and Q24 and resistor R57 operate as a differential amplifier. The collector of Q24 is connected to the positive side of the output and the collector of Q23 is connected to the positive side of its bias supply through R51 resistor. Transistor Q22 is the first dc amplifier connected in a Darlington configuration. Resistor R53 fixes the no-load operating point of Q22 and R50 provides current limiting for it. Transistor Q21 is the second amplifier connected in the Darlington configuration. Resistor R52 sets is no-load operating point.

Transistors Q18 through Q20 are the main series or pass transistors that provide a regulated output by controlling the bulk voltage. The pass transistors are controlled by the differential detector and amplifiers. R54, R55 and R56 are current sharing resistors that equalize the emitter current of the pass transistors. Capacitor C12 stabilizes the output and reduces the impedance at high frequencies. Diode CR32 protects the regulator against a reverse polarity voltage greater than 2 volts. R49 is a bleeder resistor connected across the bulk voltage supply and provides a current path to dc ground when the supply is shut off with no load applied. C23, R119 and C25 are stabilizing components that operate effectively from dc to 1500 kHz.

±6 Volt Overvoltage Circuit

The overvoltage circuits for the +6 volt and -6 volt supplies are identical in operation and circuitry. Only the +6 volt overvoltage circuit is described.

Transistor Q27 operates as an overvoltage detector. Its emitter is connected to the positive side of the +6 volt output and its base is referenced at the voltage level of zener diode CR31. Resistor R69 provides current limiting for CR31 and C32 is a stabilizing capacitor. The collector of Q27 is connected to the gate of silicon-controlled rectifier CR46, and resistor R70. When the +6 volt output rises above the zener voltage or base potential, transistor Q27 provides a gate signal for silicon-controlled rectifier CR46. CR46 turns on and shorts the +6 volt output to dc ground through resistor R70. This action quickly drops the +6 volt output to a very low value.

Current Limiting Circuits

The +6 volt, -6 volt and 24 volt current limiting circuits are identical. Only the +6 volt current-limiting circuit is described.

The +6 volt current limiting circuit is a differential detector that senses the voltage drop across one of the current-sharing resistors that is connected to the emitter of one of the pass transistors. The base of Q25 and the base of Q26, which acts as the regulator current detector, are referenced at the voltage level of zener diode CR30. Resistors R66, R68, one current sharing resistor and potentiometer R67 form a divider that is used to set the point at which current limiting begins. When the maximum current is exceeded, the increased voltage drop in the current-sharing resistor raises the base potential of Q26 through the wiper of potentiometer R67. This causes differential operation of Q25 and Q26. Because of increased base drive, Q26 conducts more than Q25, whose base is zenered at a constant potential. Q26 conducts heavily through bias resistor R51 which reduces the base drive of the regulator amplifiers. This action decreases the regulator output current.

Increased current flow through the current-sharing resistor causes further reduction in the base drive of the regulator amplifiers. The fold-back feature of the current limiting circuit is provided by resistor R65, which is connected to the negative side of the output. As the current increases, the impedance across the supply decreases, causing more current to flow through fold-back resistor R65 and divider resistor R68. This provides more base drive for Q26, which gives the fold-back feature a snapping action. A complete short circuit drops the current to a very low value, allows lower power dissipation in the pass transistors and enables the supply to sustain a short circuit for an indefinite period.

24 VDC REGULATOR

The 24 Vdc regulator is similar to the ±6 Vdc volt regulator except for the thermistor control circuit which is described separately for clarity.

Thermistor Circuit

The thermistor control circuit consists of an isolated zener supply with slope voltage adjustment, a balance bridge, and an externally connected thermistor. The thermistor (3C Part No. 932 300 004) is not supplied with the unit. It is externally connected across terminals R_T of terminal strip TB112 or TB113 and has a nominal value of 4700 ohms ±20% at 25°C. Resistors R24, R25 and R26 form one leg of the bridge; resistors R21, R22, R23 and the thermistor form the other leg. R45 adjusts the zenered slope voltage that is connected across the bridge to provide a constant current through each leg of the bridge. Resistors R23 and R24 are of equal value on the bottom portion of each leg. R25 is adjustable so that the combined resistance of R25 and R26 can be made equal to the resistance of R21, R22 and the thermistor. With the ambient temperature of the thermistor at 25°C, the bridge balancing rheostat R25 is adjusted to exactly match the resistance of the other leg of the bridge. With the bridge balanced, no current flows and the voltage drop across the bridge should be zero. The voltage drop across the bridge, measured across the blue and slate colored test jacks on PC-1 should read 0 ±10 millivolts.

If the thermistor ambient temperature changes its resistance will change causing an unbalance in the bridge and resultant voltage drop across the bridge.

The bridge output is connected between the base of transistor Q13 of the differential amplifier and resistors R31 and R32 of the sensing divider circuit. The regulator output voltage moves in proportion to the change across the bridge. The output of the 24 volt supply is set at 25°C, will move to 25.8 Vdc ±4 percent at 10°C and 19.8 Vdc ±2 percent at 60°C, which is equivalent to a compensation coefficient of approximately -0.5 percent per °C. Load current is proportional to load voltage so that as voltage decreases, current requirements will decrease.

The rate of change per °C can be varied by adjusting slope voltage potentiometer R45, which controls the amount of current through the bridge.

24 Vdc Regulator Components

The 24 Vdc regulator components function nearly the same as the +6 volt and -6 volt regulators with the following exceptions:

1. Because the output must vary over a wide range, the regulator is not operated from the output voltage but from its own zenered voltage supplied by CR22.

2. The output voltage is adjusted by potentiometer R28 which along with divider resistors R27 and R29 are placed across the zener reference diode. In the 6 volt regulators, the adjustment is contained in the sensing divider.

Zener diode CR23 furnishes a reference voltage for the regulator. Resistors R27, R28, and R29 form a divider to set the base of transistor Q12. Resistor R30 limits the current for zener diode CR-23. Resistors R31 and R32 form a sensing network for comparing a portion of the output voltage to the reference voltage on the base of transistor Q12.

Transistors Q12 and Q13 and R20 operate as a differential amplifier. The collector of Q13 is connected to the positive side of the 24V output, while the collector of Q12 is connected to a positive bias through resistor R7.

Transistor Q11 is the first dc amplifier connected in a Darlington configuration. Resistor R9 fixes the no-load operating point of Q11. Q10 is the second driver or amplifier connected in the Darlington configuration and resistor R8 sets its no-load operating point.

Transistors Q1 through Q9 are the main pass transistors that provide a regulated output by controlling the bulk voltage. The pass transistors are controlled by the differential detector and amplifiers. R11 through R19 are current sharing resistors that equalize the emitter current of the pass transistors. Capacitor C4 stabilizes the output and reduces the impedance at high frequencies. Diode CR26 protects the regulator against a reverse polarity voltage greater than 2 volts.

R5 is a bleeder resistor connected across the bulk voltage supply and provides a current path to dc ground when the supply is shutoff with no load applied.

24 Vdc Overvoltage Circuit

The 24 Vdc overvoltage circuit consists of a differential amplifier, a divider for detecting the overvoltage point, and an SCR diode to crowbar the output.

Transistors Q16 and Q17 and resistor R38 form the differential amplifier. The base of Q16 is referenced at the negative voltage level of CR23, while the base of Q17 is connected between resistors R41 and R42 of the voltage divider that is across the output of the supply. R39 and R40 resistors provide the accurate current or gate signal that fires silicon-controlled rectifier CR25 when the output reaches the overvoltage point and Q17 transistor conducts. CR24 is used as a blocking diode.

SEQUENCE CIRCUIT

Power On

The power on section of the sequencing circuit consists of relays K1, K2 and K3, resistors R91, R92 and R93, diode CR40, transistor Q35 and capacitor C27.

The coils of relays K2 and K3 are connected across the +6V and -6V outputs, respectively. A set of normally open contacts of K2 and K3 are connected in series with the divider that provides base drive for transistor Q35. The divider is connected across capacitor C17 which in turn is connected across a secondary of the ferro regulator. This secondary supplies the bulk voltage for the sequencing circuit. Relay coil K1 is in the collector lead of Q35, which is also connected across the bulk voltage supply. R91 and CR40 maintain a reverse bias (emitter to base) when transistor Q35 is not conducting. Capacitor C27 provides a delay in switching Q35 to the conducting state and energizing relay K1. A set of normally open contacts of relay K1 is connected in series with the 24 volt bias supply.

When ac power is applied to the unit, relays K2 and K3 are energized and the normally open contacts are closed. When closed, these series connected contacts complete a path for the base drive current for transistor Q35. Q35 conducts causing relay K1 to energize. A set of normally open K1 contacts close applying bias voltage to the 24 volt regulator, which allows the regulator to turn on. The output voltages can be monitored by use of an oscilloscope to observe the turn on sequence as discussed previously. Figure 2 shows the proper sequence waveforms.

Line Fault Circuit

The line fault circuit provides the proper shut down sequence for the regulators during a power failure or turn off. The regulators are also shut down when high line voltage is sensed. This circuit consists of five separate sections:

1. Line indication circuit
2. Schmitt trigger circuit
3. Fault signal circuit
4. 24V delay crowbar circuit
5. High line drop out circuit

Line Indication Circuit. -- This circuit provides a method of monitoring the condition of the input ac voltage. It consists of a center-tap winding on the primary of the ferro regulator, which feeds diodes CR20 and CR21 connected as a center tap bridge and a divider that consists of precision resistors R107 and R109 and potentiometer R108. The dc voltage across the divider is directly proportional to the input ac voltage. This changing dc voltage is used to switch a Schmitt trigger when the input line drops below a specified value. Potentiometer R108 adjusts this point at which the Schmitt trigger fires.

Schmitt Trigger. -- The Schmitt trigger circuit removes the base drive very quickly from transistor Q38 when the input voltage falls below a specified value. This circuit consists of the following components: resistors R94, R95, R96, R97, R98, R101, R113, R114, and potentiometer R115; transistors Q36 and Q37 and zener diode CR41. CR41 provides a zenered voltage to operate the trigger circuit and R94 limits the current through CR41 zener.

The Schmitt trigger is designed to switch at an input voltage of 93 - 102 Vac, which is set by potentiometer R108 in the line indication circuit. The on-off switching action is provided by transistors Q37 and Q36, respectively.

Because the Schmitt trigger switches at a different voltage level when the voltage rises than when it falls, potentiometer R115 is placed in series with the emitter of Q37 to adjust the switching rise time. Using R115, it is possible to adjust the Schmitt trigger to switch off at 93 Vac input and on at 95 Vac input; or to switch off at 102 Vac input and on at 105 Vac input. When the unit is operated at 220 Vac input, the values are doubled.

Fault Signal Circuit. -- The fault circuit provides a 4 - 6 Vdc signal rated at 10 milliamperes whenever the input ac voltage is above the minimum allowable line voltage. This section of the circuit consists of zener diode CR42, diodes CR43 and CR44, transistor Q38 and resistors R99, R100 and R103. CR43 and CR47 insure reverse base-emitter bias of Q38 when transistor Q36 is not conducting. Resistor R100 limits the current through the diodes. Zener diode CR42 provides the 4 to 6 Vdc output fault signal voltage and R99 limits the current through the zener. R103 provides a path for a sinking current of 4 milliamperes without exceeding 0.8 volts across the output. Q38 transistor is normally conducting while the unit is operating in its allowable input voltage range. When the input voltage drops below the set point of the trigger circuit, transistor Q36 switches off removing the forward bias and base drive for Q38. Transistor Q38 switches off removing the path for current flow through CR42 and the fault signal voltage falls to dc ground. The reverse action takes place when the input rises to its normal operating range. With the circuit connected in this manner, the fault signal is present if the line is normal, and falls to ground when the line is below normal.

24 Volt Delay Crowbar Circuit. -- The crowbar section of the line fault circuit provides a delay between the time the fault signal voltage falls to ground and the 24V output falls to 50 percent of its nominal value on turn-off or loss of ac power. The 24V output must be delayed 1 millisecond following grounding of the fault signal and must be below

50 percent of its nominal value within 2 milliseconds. The circuit consists of resistors R102, R104 and R105, capacitor C21, diode CR39, transistor Q39, and relay K4. CR39 ensures that the base-emitter of Q39 is reverse biased, when Q37 is not conducting. Resistor R104 limits the current through CR39. Resistor R105 and the coil of relay K1 are connected in series with the collector of Q39 transistor. C21 and R102 form an RC network which ramps up the forward bias of Q39. R102 is adjustable to vary the ramp up time.

When the Schmitt trigger switches on a low line condition, transistor Q37 conducts applying a forward bias and base drive to Q39, delayed by the RC network R102 and C21. When Q39 conducts, K4 is energized. A set of normally open K4 contacts are connected from the gate of silicon-controlled rectifier CR25 to the positive 24V output. When K4 is energized, these contacts close and a positive gate voltage is applied to CR25 and the SCR fires. This crowbars the 24 volt output and completes the sequence-off procedure.

High Line Dropout Circuit. -- The high line dropout circuit drops the fault signal to ground in 10 milliseconds or less during a high line voltage condition. This section consists of diodes CR48, CR49 and CR50; capacitors C20 and C33; and resistors R106, R121 and R120. Zener diode CR48 is in series with potentiometer R120 and resistor R106. This network is connected across the line indication voltage. R106 and R120 limit the current through zener CR48. Potentiometer R120 adjusts the point at which zener CR48 goes into its zener region. The value of R106 is selected so that, during a high input voltage condition, zener CR48 conducts only when a line transient from the line indication voltage exceeds the zener voltage. When zener CR48 conducts in its zener region, it produces a gate signal that fires silicon-controlled rectifier CR49, which is connected across the source of triggering voltage for the Schmitt trigger. Diode CR50 and resistor R121 keep the gate of CR49 from becoming positive during normal operation. Capacitor C33 also desensitizes the SCR to prevent nuisance firing. Capacitor C20 reduces the ripple content of the triggering voltage that switches the Schmitt trigger.

VOLTAGE MONITORING CIRCUIT

The voltage monitoring circuit is used to check output voltage levels of the +6V, -6V and 24V regulators at the output terminals by use of a 4 position, 2 pole switch and an optional milliammeter with a 0 - 1 mA scale. If the meter is not included in the unit, any milliammeter that reads 1 mA full scale may be used. Test jacks are provided, if the meter is not included in the unit. Precision resistor R110, R111, R112 limit each voltage regulator circuit to 1 milliampere at 120 percent of nominal output. The meter available with the unit is scaled in percent of output.

TROUBLESHOOTING GUIDE

The most frequent malfunctions and associated possible causes are listed below.

Series Regulators

A. No Output Voltage

1. Check for blown fuse (input and output).
2. Check input switch (S1).
3. Check for voltage at collector of pass transistors.
4. Check reference zener for a short or open circuit.
5. Check differential transistors for open or short circuits.
6. Check driver amplifiers for open circuit.
7. Check bias voltage at amplifier.
8. Check overvoltage circuit.

NOTE

Any condition which results in an overvoltage will crowbar the output and blow the fuse in the collector lead of the pass transistors.

B. Low Output Voltage

1. Check series collector voltage for proper input to regulator.
2. Check comparison divider for an open circuit.
3. Check voltage level of bias supply.
4. Check differential transistors.
5. Check thermistor control circuit, if 24V output is low.

C. High Output Voltage and Ripple

NOTE

If any output has a high bulk output voltage, the circuit has problems with the overvoltage section also.

1. Check pass transistors for short circuits.
2. Check comparison divider for open circuit.
3. Check differential transistors for short circuits.

±6 Volt Overvoltage Circuits

A. Circuit Does Not Crowbar on Overvoltage

1. Check CR46 or CR38 for damage (broken gate lead, etc.)
2. Check Q27 or Q34 for open or short circuits.
3. Check CR31 or CR37 zener for proper voltage.

B. Circuit Crowbars on Turn-On

NOTE

Any failure causing the output to rise above the overvoltage firing point will crowbar the output.

1. Check Q27 and Q24 for an open circuit.
2. Check CR46 and CR38 for short circuits.

24 Volt Overvoltage Circuit

A. Circuit Will Not Crowbar on Overvoltage

1. Check Q16 and Q17 for open or short circuits.
2. Check R77 for proper reference voltage.
3. Check divider R41 and R42 for proper values.

B. Circuit Will Not Crowbar on Turn-Off

1. Check 24 volt delay crowbar circuit.
2. Check relay K4 for proper operation.

NOTE

If crowbar circuit operates properly on overvoltage, the SCR is not defective.

C. Circuit Crowbars on Turn-On

1. Check differential transistors for open or short circuits.
2. Check regulator for an overvoltage condition causing SCR to crowbar.
3. Check contacts of K4.

Temperature Compensation

A. The 24V Output Does Not Change with a Change in the Temperature Compensation Resistor (R_T)

1. Check R_T for proper connection.
2. Check R_T for proper value.

B. The 24V Output Changes Too Much or Too Little with Temperature

1. Check for proper setup at 25°C.
2. Check CR28 voltage level.
3. Check for installation of proper thermistor (R_T).

TEST POINTS

24 Volt Card (PC1)

NOTE

Output set at 24 Vdc, 13A at 25°C.

From	To Test Jack	Reading (±2%)
(+) Output	Violet	3 Vdc
(+) Output	Black	10 Vdc
(+) Output	Slate	5 Vdc
(+) Output	Natural	3.6 Vdc
Red Test Jack	Orange	29.7 Vdc
(+) Output	Yellow	5 Vdc
(+) Output	Blue	5 Vdc
(+) Output	Brown	8.15 Vdc

+6 Volt Card (PC2)

NOTE

Output set at +6 Vdc, 10A.

From	To Test Jack	Reading (±2%)
(+) Output	Black	3 Vdc
(+) Output	Red	3.6 Vdc

-6 Volt Card (PC3)

NOTE

Output set at -6 Vdc, 1.5A.

From	To Test Jack	Reading (±20%)
(+) Output	Black	3 Vdc
(+) Output	Blue	3 Vdc
(+) Output	Red	3.7 Vdc

ELECTRICAL PARTS LIST

Electrical parts are listed in the following table. Printed circuit card assemblies are illustrated in Figures 2-5 through 2-8. The schematic diagram is presented in Figure 2-9.

Electrical Parts List, Model MP-40/MP-40E

Ref. Desig.	Description	North Electric Part No.
B1	Blower	312 0014
C1	CAPACITOR: 0.047 μF, 100 Vdc	304 0993
C2	CAPACITOR: 750 μF, 35 Vdc	304 1294
C3, C8	CAPACITOR: 2600 μF, 30 Vdc	304 2037
C4	CAPACITOR: 12, 500 μF, 50 Vdc	304 1052
C5	CAPACITOR: 10 μF, 660 Vac, 60 Hz	304 1023
C5	CAPACITOR: 12 μF, 660 Vac, 50 Hz	304 1024
C6	CAPACITOR: 4, 200 μF, 50 Vdc	304 2015
C7	CAPACITOR: 750 μF, 35 Vdc	304 1294
C9, C10	CAPACITOR: 60, 000 μF, 20 Vdc	304 2034
C12	CAPACITOR: 12, 000 μF, 10 Vdc	304 2021
C13, C29, C30, C31	CAPACITOR: 0.15 μF, 100 Vdc	304 0968
C14	CAPACITOR: 2600 μF, 30 Vdc	304 2037
C15	CAPACITOR: 17, 000 μF, 15 Vdc	304 2050
C16	CAPACITOR: 2250 μF, 10 Vdc	304 0763
C17	CAPACITOR: 2600 μF, 30 Vdc	304 2037
C18	CAPACITOR: 32, 000 μF, 40 Vdc	304 1212
C19, C23	CAPACITOR: 0.022 μF, 100 Vdc	304 0981
C20	CAPACITOR: 25 μF, 50 Vdc	304 0748
C21	CAPACITOR: 15 μF, 25 Vdc	304 1278
C22	CAPACITOR: 0.033 μF, 100 Vdc	304 0980
C24	CAPACITOR: 0.015 μF, 100 Vdc	304 0977

Electrical Parts List, Model MP-40/MP-40E (Cont)

Ref. Desig.	Description	North Electric Part No.
C25, C26	CAPACITOR: 0.068 μF, 100 Vdc	304 0966
C27	CAPACITOR: 120 μF, 25 Vdc	304 1214
C28	CAPACITOR: 10 μF, 50 Vdc	304 1222
C32	CAPACITOR: 10 μF, 20 V	304 1064
C33	CAPACITOR: 0.0022 μF, 100 Vdc	304 1048
CR1-CR4	DIODE: Replacement Type 1N645	337 1363
CR5 - CR6	DIODE: Replacement Type 368D	337 1271
CR7 - CR12	DIODE: Replacement Type 1N645	337 1363
CR13 - CR14	DIODE: Replacement Type 368D	337 1271
CR15 - CR16	DIODE: Replacement Type 1N645	337 1363
CR17 - CR18	DIODE: Replacement Type 1N4721	337 1356
CR19	DIODE: Replacement Type 1N1185	337 1192
CR20 - CR21	DIODE: Replacement Type 1N645	337 1363
CR22	DIODE, ZENER: Replacement Type 1N3793B	337 1354
CR23	DIODE, ZENER: Replacement Type 1N4295A	337 1230
CR24	DIODE: Replacement Type 1N645	337 1363
CR25	DIODE, SCR: Replacement Type 2N682	337 1221
CR26	DIODE: Replacement Type 1N1185	337 1192
CR27	DIODE: Replacement Type 1N645	337 1363
CR28	DIODE, ZENER: Replacement Type 1N2990A	337 1375
CR29	DIODE, ZENER: Replacement Type 1N3793B	337 1354
CR30	DIODE, ZENER: Replacement Type 1N4295A	337 1230
CR31	DIODE, ZENER: Replacement Type 1N753A	337 1068
CR32	DIODE: Replacement Type 1N1185	337 1192
CR33	DIODE: Replacement Type 1N645	337 1363
CR34	DIODE, ZENER: Replacement Type 1N3793B	337 1354
CR35	DIODE, ZENER: Replacement Type 1N4295A	337 1230
CR36	DIODE: Replacement Type 1N645	337 1363
CR37	DIODE, ZENER: Replacement Type 1N753A	337 1068
CR38	DIODE, SCR: Replacement Type 2N1842	337 1064
CR39, CR40 CR50, CR51	DIODE: Replacement Type 1N645	337 1363
CR41	DIODE, ZENER: Replacement Type 1N2984B	337 1090

Electrical Parts List, Model MP-40/MP-40E (Cont)

Ref. Desig.	Description	North Electric Part No.
CR42	DIODE, ZENER: Replacement Type 1N752A	337 1092
CR43, CR44, CR45	DIODE: Replacement Type 1N645	337 1363
CR46	DIODE, SCR: Replacement Type 2N1842	337 1064
CR47	DIODE: Replacement Type 1N645	337 1363
CR48	DIODE, ZENER: Replacement Type 1N3984B	337 1090
CR49	DIODE, SCR: Replacement Type 2N1595	337 1105
F1	FUSE: 115 Vac In. AGC 10 A	315 0101
F1	FUSE: 230 Vac In. AGC 5 A	315 0242
F2	FUSE: MDL 20 A	315 0367
F3	FUSE: MDL 0.25 A	315 0273
F4	FUSE: AGC 15 A	315 0079
F5	FUSE: AGC 5 A	315 0242
K1	RELAY: 12 Vdc	053 8656
K2	RELAY: 6 Vdc	053 6804
K3	RELAY: 6 Vdc	053 6804
K4	RELAY: 12 Vdc	053 8656
LP1	AC ON LAMP:	321 0053
M1 (Optional)	0-1 MA DC METER:	327 0205
P1	AC INPUT PLUG:	333 0123
Q1 - Q10	TRANSISTOR: Replacement Type 2N3055	370 0161
Q11	TRANSISTOR: Replacement Type 2N1485	370 0055
Q12 - Q15	TRANSISTOR: Replacement Type 2N1613	370 0072
Q16 - Q17	TRANSISTOR: Replacement Type 2N3133	370 0144
Q18 - Q21	TRANSISTOR: Replacement Type 2N3055	370 0161
Q22	TRANSISTOR: Replacement Type 2N1485	370 0055
Q23 - Q26	TRANSISTOR: Replacement Type 2N1613	370 0072
Q27	TRANSISTOR: Replacement Type 2N3133	370 0144
Q28	TRANSISTOR: Replacement Type 2N3055	370 0161
Q29	TRANSISTOR: Replacement Type 2N1485	370 0055

Electrical Parts List, Model MP-40/MP-40E (Cont)

Ref. Desig.	Description	North Electric Part No.
Q30 - Q33	TRANSISTOR: Replacement Type 2N1613	370 0072
Q34	TRANSISTOR: Replacement Type 2N3133	370 0144
Q35 - Q37	TRANSISTOR: Replacement Type 2N1613	370 0072
Q38, Q39	TRANSISTOR: Replacement Type 2N3133	370 0144
R1	RESISTOR: 1 ohm, ±10%, 25 W	340 7401
R2	RESISTOR: 2400 ohms, ±5%, 1/2 W	340 0162
R3	RESISTOR: 5 ohms, ±5%, 3 W	340 5247
R4	RESISTOR: 90 ohms, ±5%, 5 W	340 1758
R5	RESISTOR: 100 ohms, ±5%, 25 W	340 2923
R6	RESISTOR: 200 ohms, ±5%, 2 W	340 0831
R7	RESISTOR: 3300 ohms, ±5%, 1/2 W	340 0165
R8	RESISTOR: 910 ohms, ±5%, 1 W	340 0624
R9	RESISTOR: 2400 ohms, ±5%, 1/2 W	340 0162
R10	NOT USED	
R11 - R19	RESISTOR: 0.2 ohm, ±1%, 5 W	340 1775
R20	RESISTOR: 1000 ohms, ±1%, 1/2 W	340 0153
R21	RESISTOR: 2200 ohms, ±1%, 1 W	340 5576
R22, R23, R24	RESISTOR: 1000 ohms, ±1%, 1 W	340 0769
R25	RESISTOR, VARIABLE: 100 ohms, ±10%	341 0562
R26	RESISTOR: 825 ohms, ±1%, 3 W	340 5010
R27	RESISTOR: 415 ohms, ±1%, 3 W	340 5316
R28	RESISTOR, VARIABLE: 200 ohms, ±5%, 2 W	341 0446
R29	RESISTOR: 415 ohms, ±1%, 3 W	340 5316
R30	RESISTOR: 140 ohms, ±1%, 3 W	340 5089

Electrical Parts List, Model MP-40/MP-40E (Cont)

Ref. Desig.	Description	North Electric Part No.
R31	RESISTOR: 250 ohms, ±1%, 1 W	340 5552
R32	RESISTOR: 950 ohms, ±1%, 3 W	340 5125
R33	RESISTOR: 470 ohms, ±5%, 1 W	340 0617
R34	RESISTOR: 125 ohms, ±1%, 1/2 W	340 0486
R35	RESISTOR, VARIABLE: 50 ohms, ±10%	341 0561
R36	RESISTOR: 430 ohms, ±1%, 1/2 W	340 0490
R37	RESISTOR: 5850 ohms, ±1%, 3 W	340 5202
R38	RESISTOR: 470 ohms, ±5%, 1/2 W	340 0145
R39	RESISTOR: 430 ohms, ±5%, 1/2 W	340 0144
R40	RESISTOR: 200 ohms, ±5%, 1/2 W	340 0136
R41	RESISTOR: 500 ohms, ±1%, 1 W	340 5555
R42	RESISTOR: 975 ohms, ±1%, 3 W	340 5070
R43	RESISTOR: 910 ohms ±5%, 1 W	340 0624
R44	RESISTOR: 90 ohms, ±5%, 5 W	340 1758
R45	RESISTOR, VARIABLE: 100 ohms, ±10%	341 0562
R46	RESISTOR: 825 ohms, ±1%, 3 W	340 5010
R47	RESISTOR: 5 ohms, ±5%, 3 W	340 5247
R48	RESISTOR: 110 ohms, ±5%, 2 W	340 0825
R49	RESISTOR: 30 ohms, ±5%, 5 W	340 1701
R50	RESISTOR: 250 ohms, ±5%, 5 W	340 8022
R51	RESISTOR: 3900 ohms, ±5%, 1/2 W	340 0167
R52	RESISTOR: 510 ohms, ±5%, 1/2 W	340 0146

Electrical Parts List, Model MP-40/MP-40E (Cont)

Ref. Desig.	Description	North Electric Part No.
R53	RESISTOR: 4300 ohms, ±5%, 1/2 W	340 0168
R54 - R56	RESISTOR: 0.2 ohm, ±1%, 5 W	340 1775
R57	RESISTOR: 240 ohms, ±5%, 1/2 W	340 0138
R58	RESISTOR: 300 ohms, ±1%, 1/2 W	340 0476
R59	RESISTOR: 700 ohms, ±1%, 3 W	340 5120
R60	RESISTOR: 240 ohms, ±5%, 1/2 W	340 0138
R61	RESISTOR: 100 ohms, ±1%, 1/2 W	340 0382
R62	RESISTOR, VARIABLE: 50 ohms, ±5%, 2 W	341 0414
R63	RESISTOR: 70 ohms, ±1%, 1 W	340 5580
R64	RESISTOR: 1200 ohms, ±5%, 1/2 W	340 0155
R65	RESISTOR: 1580 ohms, ±1%, 3 W	340 5232
R66	RESISTOR: 200 ohms, ±1%, 1/2 W	340 0493
R67	RESISTOR, VARIABLE: 50 ohms, ±10%	341 0561
R68	RESISTOR: 680 ohms, ±1%, 2 W	340 1090
R69	RESISTOR: 1200 ohms, ±5%, 1 W	340 0627
R70	RESISTOR: 180 ohms, ±5%, 1/2 W	340 0135
R71	RESISTOR: 90 ohms, ±5%, 5 W	340 1758
R72	RESISTOR: 1 ohm, ±5%, 3 W	340 5239
R73	RESISTOR: 3900 ohms, ±5%, 1/2 W	340 0167
R74	RESISTOR: 10 ohms, ±5%, 1/2 W	340 0100
R75	RESISTOR: 1300 ohms, ±5%, 1/2 W	340 0156
R76	RESISTOR: 0.2 ohm, ±1%, 5 W	340 1775

Electrical Parts List, Model MP-40/MP-40E (Cont)

Ref. Desig.	Description	North Electric Part No.
R77	RESISTOR: 300 ohms, ±1%, 1/2 W	340 0476
R78	RESISTOR: 700 ohms, ±1%, 3 W	340 5120
R79	RESISTOR: 700 ohms, ±1%, 3 W	340 5120
R80	RESISTOR: 240 ohms, ±5%, 1/2 W	340 0138
R81	RESISTOR: 100 ohms, ±1%, 1/2 W	340 0382
R82	RESISTOR, VARIABLE: 50 ohms, ±5%, 2 W	341 0414
R83	RESISTOR: 70 ohms, ±1%, 1 W	340 5580
R84	RESISTOR: 1200 ohms, ±5%, 1/2 W	340 0155
R85	RESISTOR: 150 ohms, ±1%, 1 W	340 5551
R86	RESISTOR, VARIABLE: 50 ohms, ±10%	341 0561
R87	RESISTOR: 2260 ohms, ±1%, 3 W	340 5181
R88	RESISTOR: 680 ohms, ±1%, 2 W	340 1090
R89	RESISTOR: 1500 ohms, ±5%, 1 W	340 0629
R90	RESISTOR: 180 ohms, ±5%, 1/2 W	340 0135
R91	RESISTOR: 2400 ohms, ±5%, 1/2 W	340 0162
R92	RESISTOR: 2200 ohms, ±5%, 1/2 W	340 0161
R93	RESISTOR: 200 ohms, ±5%, 1/2 W	340 0136
R94	RESISTOR: 15 ohms, ±5%, 2 W	340 0804
R95	RESISTOR: 300 ohms, ±5%, 1/2 W	340 0140
R96	RESISTOR: 100 ohms, ±5%, 1/2 W	340 0129
R97	RESISTOR: 200 ohms, ±5%, 1/2 W	340 0136
R98	RESISTOR: 300 ohms, ±5%, 1/2 W	340 0140

Electrical Parts List, Model MP-40/MP-40E (Cont)

Ref. Desig.	Description	North Electric Part No.
R99	RESISTOR: 180 ohms, ±5%, 2 W	340 0830
R100	RESISTOR: 2400 ohms, ±5%, 1/2 W	340 0162
R101	RESISTOR: 100 ohms, ±5%, 1/2 W	340 0129
R102	RESISTOR, VARIABLE: 1000 ohms, ±10%	341 0565
R103	RESISTOR: 180 ohms, ±5%, 1/2 W	340 0135
R104	RESISTOR: 2400 ohms, ±5%, 1/2 W	340 0162
R105	RESISTOR: 1500 ohms, ±5%, 1/2 W	340 0157
R106	RESISTOR: 3000 ohms, ±5%, 1/2 W	340 0164
R107	RESISTOR: 150 ohms, ±1%, 1 W	340 5551
R108	RESISTOR, VARIABLE: 500 ohms, ±10%	341 0564
R109	RESISTOR: 100 ohms, ±1%, 1/2 W	340 0382
R110	RESISTOR: 28, 800 ohms, ±1%, 3 W	340 5359
R111, R112	RESISTOR: 7200 ohms, ±1%, 3 W	340 5360
R113	RESISTOR: 1000 ohms, ±5%, 1/2 W	340 0153
R114	RESISTOR: 620 ohms, ±5%, 1/2 W	340 0148
R115	RESISTOR, VARIABLE: 200 ohms, ±10%	341 0563
R116	RESISTOR: 240 ohms, ±5%, 1/2 W	340 0138
R117	RESISTOR: 300 ohms, ±1%, 1/2 W	340 0476
R118	RESISTOR: 56 ohms, ±5%, 2 W	340 0818
R119	RESISTOR: 10 ohms, ±1%, 1/2 W	340 0100
R120	RESISTOR, VARIABLE: 5000 ohms, ±5%	341 0521
R121	RESISTOR: 1000 ohms, ±5%, 1/2 W	340 0153

Electrical Parts List, Model MP-40/MP-40E (Cont)

Ref. Desig.	Description	North Electric Part No.
S1	AC ON SWITCH:	366 0371
S2	METER SWITCH:	366 0412
TS1	THERMOSWITCH:	366 0362
VR1	FERRO REGULATOR: 60 Hz	611 4128
VR1	FERRO REGULATOR: 50 Hz	611 4129

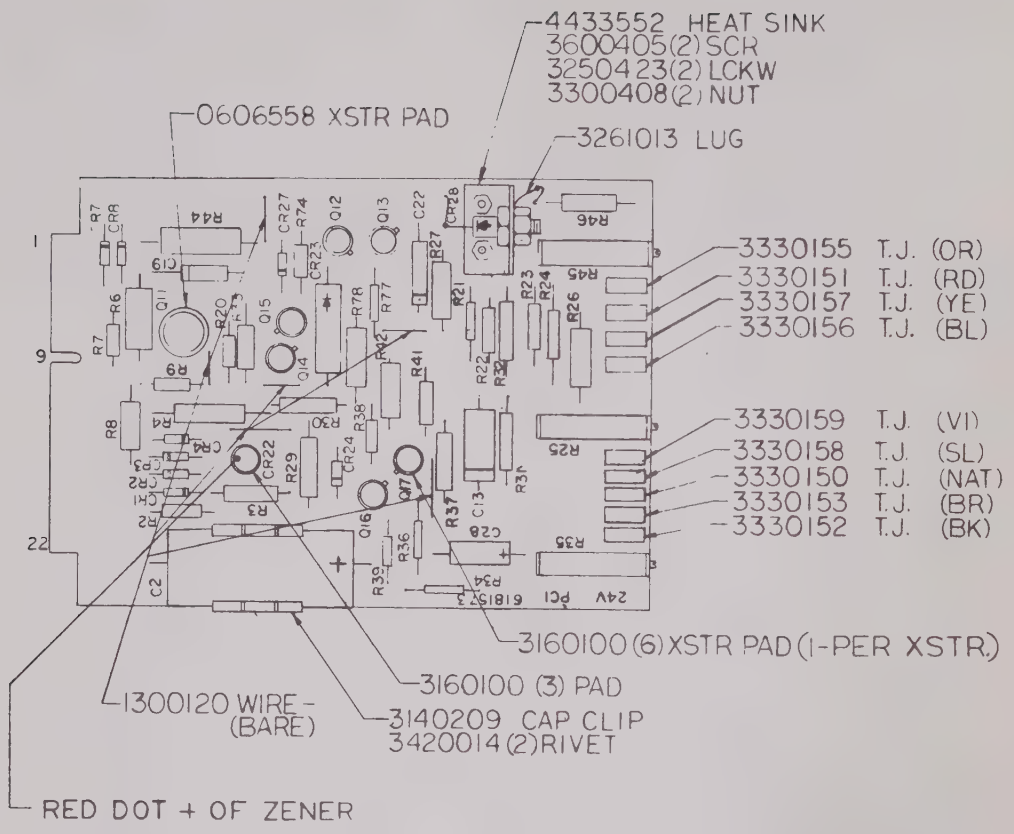


Figure 2-5. Printed Circuit Card Assembly PC-1, 24 Volt Circuit (618573)

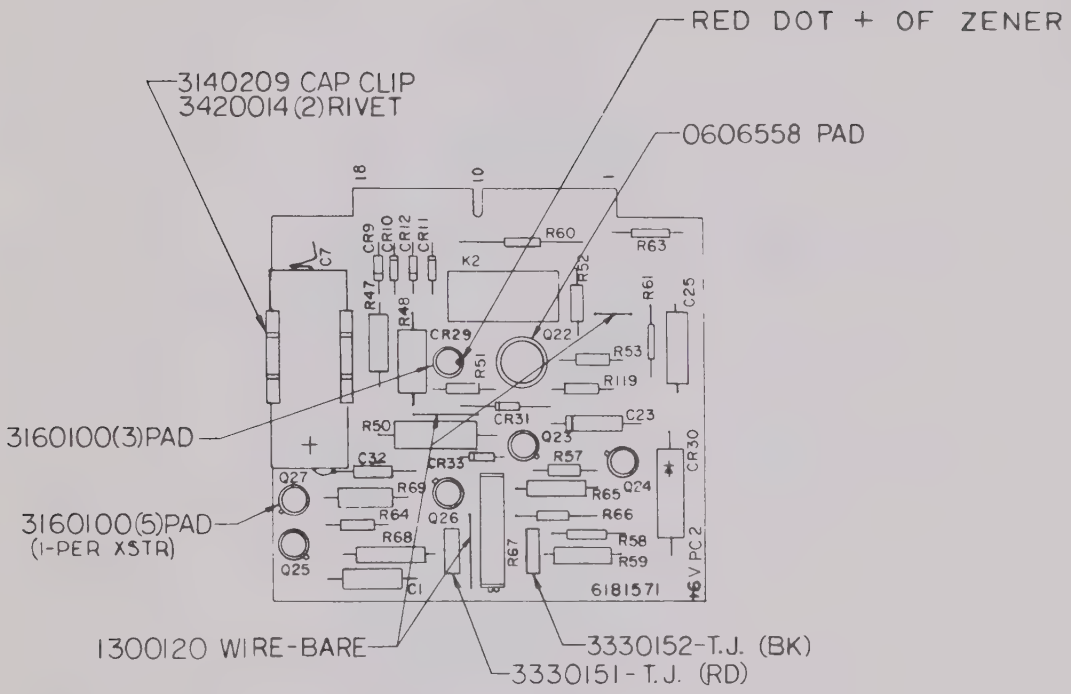


Figure 2-6. Printed Circuit Card Assembly PC-2, +6 Volt Circuit (6186571)

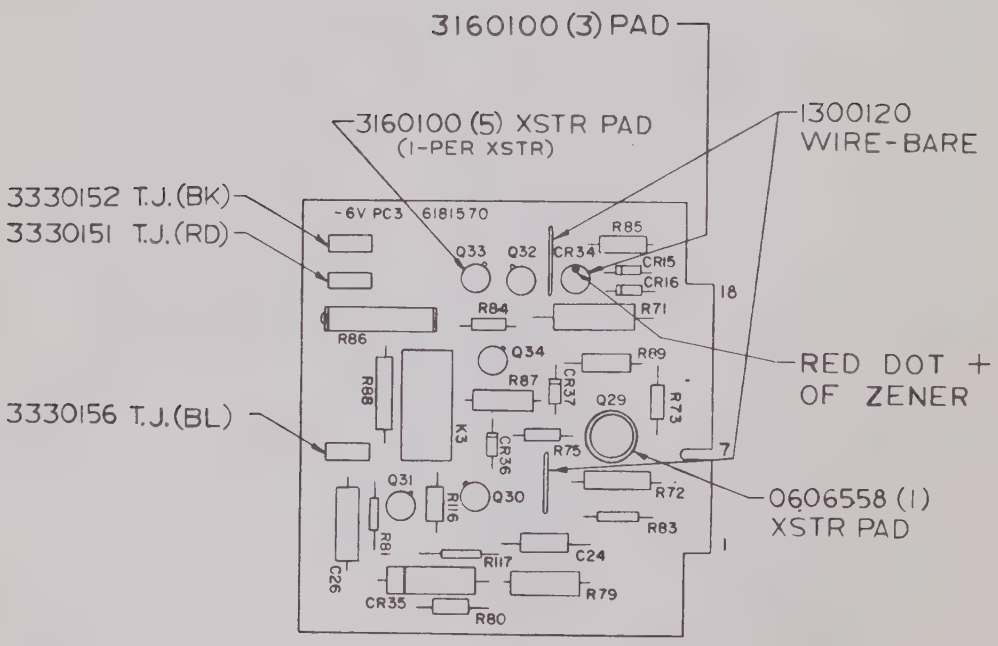


Figure 2-7. Printed Circuit Card Assembly PC-3, -6 Volt Circuit (6186570)

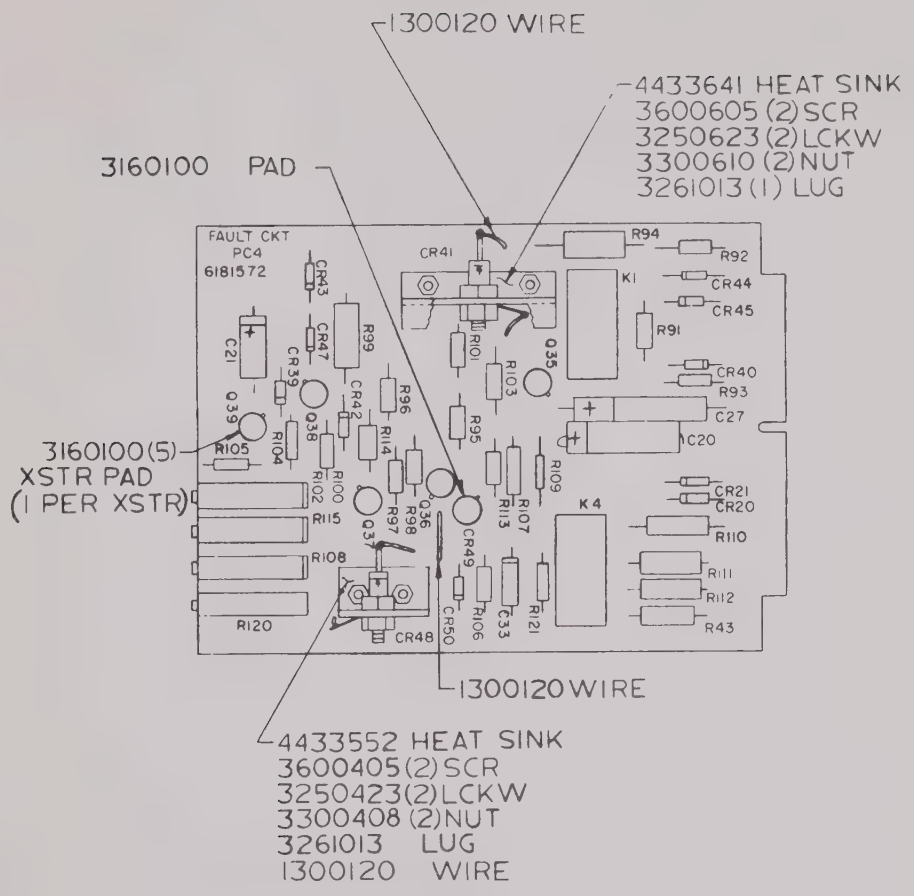
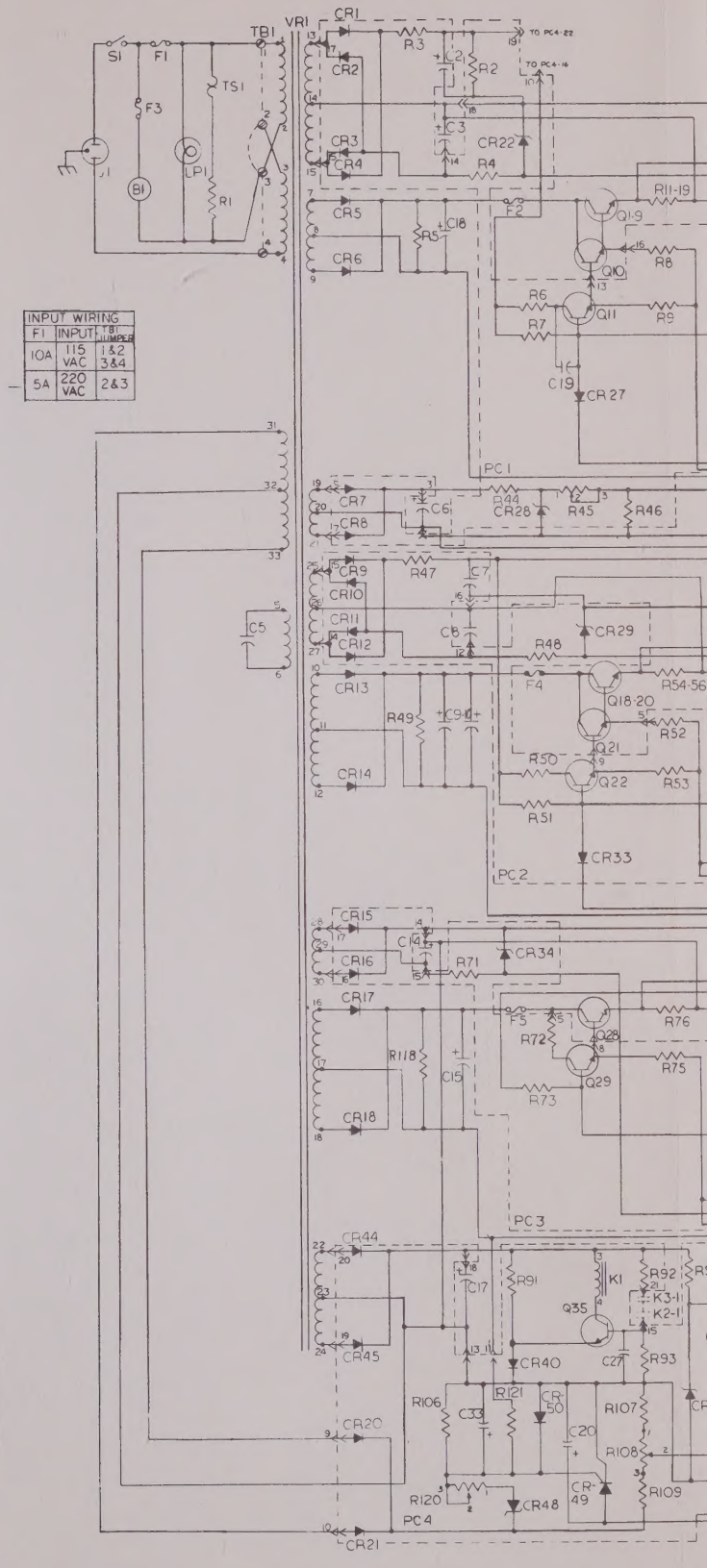


Figure 2-8. Printed Circuit Card Assembly PC-4, Fault Circuit (6186572)


INPUT WIRING
F1 | INPUT | TB1 JUMPER
10A | 115 VAC | 1&2, 3&4
5A | 220 VAC | 2&3
S1
F1
F3
TS1
TB1
VR1
CR1
B1
LP1
R1
CR2
CR3
CR4
R3
R2
C2
C3
CR22
R4
TO PC4-22
TO PC4-16
CR5
CR6
R5
C18
F2
Q1-9
Q10
R8
R11-19
R6
R7
Q11
R9
C19
CR27
PC1
CR7
CR8
C61
R44
CR28
R45
R46
CR9
CR10
CR11
CR12
R47
C7
C6
CR29
R48
C5
CR13
CR14
R49
C9
F4
Q18-20
R54-56
Q21
R52
R50
Q22
R53
R51
CR33
PC2
CR15
CR16
C14
CR34
R71
CR17
CR18
R118
C15
F5
R72
Q28
Q29
R76
R75
R73
PC3
CR44
CR45
C17
R91
K1
R92
K3-1
K2-1
Q35
C27
R93
CR40
R121
CR50
R106
C33
C20
R107
R108
R109
R120
CR48
CR49
CR20
CR21
PC4

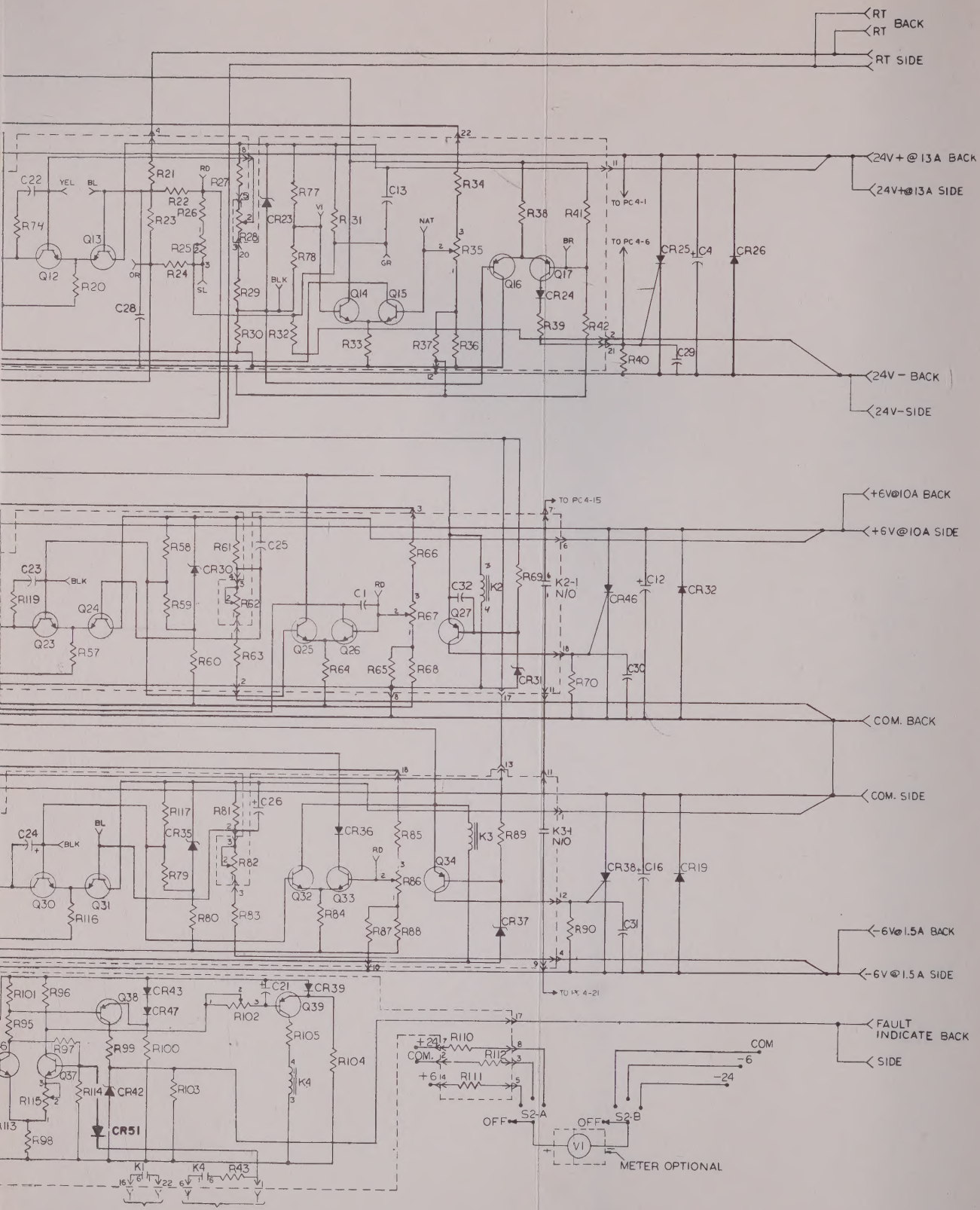


Figure 2-9. Power Supply, Model MP-40/MP-40E, Schematic Diagram (4391415)

550.1

550.1

Date Due

ME-4942

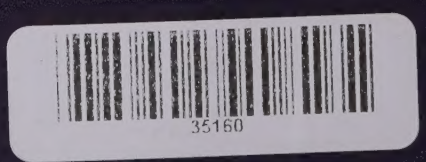
Honeywell

AUTHOR
Power Supply

TITLE
MP-40/MP-40E

DATE LOANED	BORROWER'S NAME	DATE RETURNED

PRINTED IN U.S.A.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